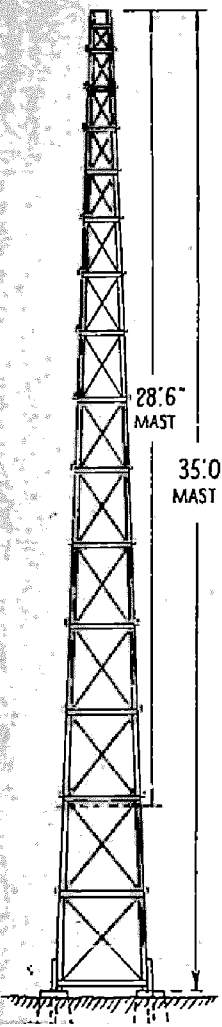

MAST & AERIAL CONSTRUCTION FOR AMATEURS

by F. J. AINSLEY, A.M.I.C.E.

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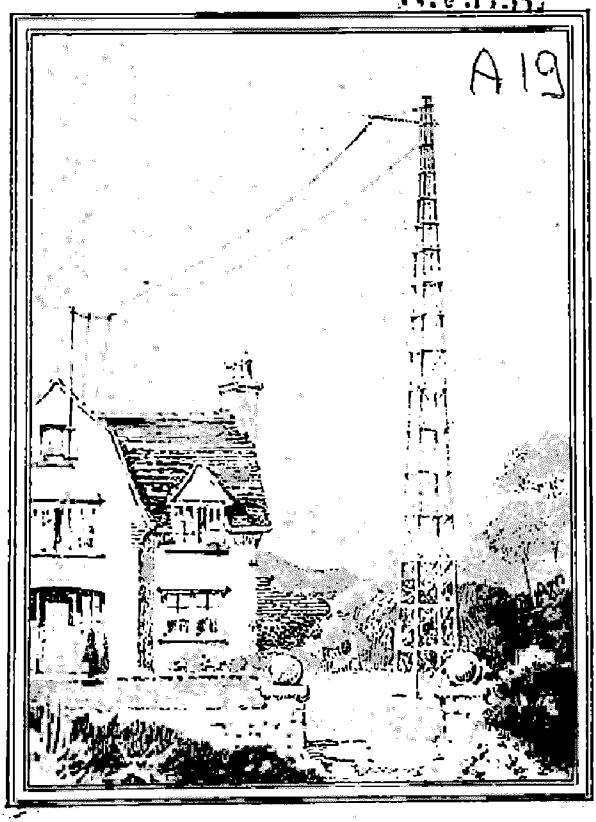
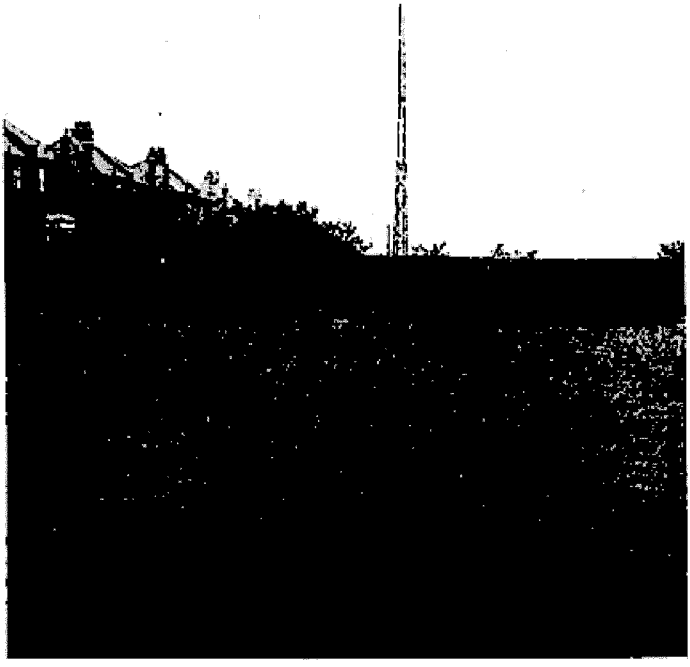


Price 1/6

LONDON: THE WIRELESS PRESS, LTD.,
12 & 13, HENRIETTA STREET, W.C. 2.

de Historie v/d Radio



36 FEET MAST, SELF-SUPPORTING TYPE.

MAST AND AERIAL CONSTRUCTION FOR AMATEURS

A19

TOGETHER WITH THE METHOD OF ERECTION AND OTHER USEFUL INFORMATION

BY

F. J. AINSLEY, Assoc.M.Inst.C.E.

70 *ILLUSTRATIONS*

LONDON

THE WIRELESS PRESS, LTD.

12 & 13, HENRIETTA STREET, W.C. 2.

NEW YORK: WIRELESS PRESS INC., 326, BROADWAY

SYDNEY, N.S.W.: 97, CLARENCE STREET

1922

THE WIRELESS PRESS, LTD.

FOREIGN AND COLONIAL AGENCIES:

SYDNEY, N.S.W.: 97, Clarence Street.

MELBOURNE: 422/4, Little Collins Street.

MADRID: La Prensa Radiotelegrafica, 43, Calle de Alcala.

GENOA: Agenzia Radiotelegrafica Italiana, Via Varese 3.

AMSTERDAM: Nederlandsch Presbureau Radio, 562, Keizersgracht.

PREFACE

In introducing this book the author hopes to assist all those who are interested in the reception of wireless telegraphy and telephony, and wish to construct their own apparatus.

Although it is not essential to possess an outside aerial with every receiving set, yet the majority of amateurs, who are anxious to obtain an efficient installation at minimum expense, will find that by introducing an outside aerial system much expense can be saved, as the apparatus required in the receiving circuit need not be so elaborate to obtain equivalent results.

Many amateurs will, no doubt, be faced with the difficulty of obtaining suitable attachments for the aerial, and to assist them to overcome these difficulties, various types of masts are set out in this book.

In reading through the following pages, the amateur will find out that it is possible to supply a long-felt want, at a comparatively low cost, within the compass of his own ability and the use of a few ordinary tools.

When completed, the masts are easily erected. The stays and foundations are fully dealt with, together with everything necessary to complete the aerial system.

Throughout the book simplicity has been the keynote, but there is nothing to prevent the amateur using more elaborate attachments, connections, anchors, etc., providing the necessary strength is maintained.

Chapter II. should be studied before constructing and erecting any of the masts given in this book.

Before arranging to attach the aerial to the house it is advisable to consult the landlord.

At the time of going to press the regulations relating to the length of aerial wire read: "The length of wire from the instrument to the far insulator in the aerial must not exceed 100 feet irrespective of the number of wires."

The cost of the material for the 36 ft. mast shown in the three illustrations was twenty-five shillings.

The amateur can therefore see that the cost of the material for the various masts given is not prohibitive.

F. J. A.

UPMINSTER,
September 30th, 1922.

BIBLIOTHEEK
N.V.H.R.

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MASTS

CHAPTER I

VARIOUS TYPES OF MASTS

THE general principles and design of masts, shown in this book, offer to the amateur structures that combine strength with simplicity of construction.

With the assistance of the detailed drawings and notes, it is hoped that no troubles will be met with which will call for skill beyond that of the ordinary handyman.

The various types shown are graduated in design, so that each individual's requirements can be suited. The simpler forms require few tools, a minimum of craftsmanship and expense.

The cheapest and most easily obtained pole for a wireless mast is a builder's scaffold pole, but beyond a height of about 25 feet it is difficult to obtain also locally. However, they can be purchased in the right quarter, and cost barely a shilling a foot, up to a height of about 32 feet. Beyond this they become expensive, and the difficulties of transport to the site arise, so that other means may have to be employed for obtaining a mast.

One alternative is a plank mast. This type is easy to construct, and cheap.

Another form is the stayed lattice mast. This also is of simple construction, and works out at roughly a shilling a foot.

The self-supporting mast needs a little more care during construction, but should not be beyond the power of the general handyman, and has the advantage of requiring little ground space.

A more permanent form of mast is shown (Chapter VII.), and consists of iron or steel tubes screwed and socketed together; the initial cost of this is somewhat heavy, and the tools required are not generally in the possession of the ordinary individual.

For those who consider the erection of a mast of this character,

36 feet Mast, Base 18 inches square, Head 6 inches square, Legs $1\frac{3}{8}$ inches square, Struts 1 inch × $\frac{3}{4}$ inch.

it would be better to place the work out to a plumber or gas-fitter, and only undertake the actual erection themselves.

The height of each of the foregoing types has been made variable within limits, to suit the requirements of each individual, but in most cases, 36 feet in height will be sufficient, and, keeping within this limit, the difficulties of erection are simplified.

The various types are fully dealt with in their respective chapters, so that little more need be said here, beyond advising the amateur to construct his mast according to the plank or stayed lattice type, unless a pole is easily procurable. These types will give him sufficient height, combined with ease and quickness of construction, few tools and minimum expense.

CHAPTER II

GENERAL INFORMATION

Timber.—The selection of the timber for any of the masts, is the most important item to be considered before attempting to build one up.

Yellow deal is the name of the timber required, and it is this class that can be seen stacked in all timber yards.

The particular sections for building the masts are called battens in the timber trade, and for small quantities are sold by the 100-foot run.

The size of timber to be ordered includes the thickness of the saw cut, which is about $\frac{1}{8}$ inch wide, therefore, $1\frac{1}{2}$-inch square battens will only be $1\frac{3}{8}$ inches square when measured.

If you require your battens to be $1\frac{1}{2}$ inches square, you must ask for them to "hold up" (trade term) to $1\frac{1}{2}$ inches square. There will correspondingly be a slight increase in price for this.

The actual size for each piece in the masts is given, also the size by which you must order them.

The general specification for timber states that the wood must be free from sap, shakes, large or loose knots, twists, warps, or waney edges. Timber only holds to these requirements under special prices, but the bulk of cheap timber sold does not vary seriously from the specification requirements.

36 feet Mast, showing Construction and Strength for Climbing.

Sapwood is unseasoned timber. This defect need not be looked for, as the battens will be practically free from this, and even if it existed slightly, it would not be detected by the inexperienced eye.

Shakes.—Cracks or crevices; these are not likely to exist to any extent and are easily seen.

Knots, persistently exist, are round or oval, of reddish brown colour; pieces with large or loose knots must be rejected.

Twists and Warps.—Twisted or mis-shapened timber must be guarded against, especially for the leg members. Slight bends in the timber in one plane or direction of an inch in 12 feet can be accepted.

Waney Edges.—Corner bevelled or cut away.

To sum up, the purchaser should ask for good yellow deal, free from large or loose knots, twists or warps, and then reject any pieces that do not suit his requirements. The timber-yard foreman will select your timber and, generally, it will be all you desire.

Do not be too drastic in your specification or you will be charged for "best selected timber."

Strength of Timber.—The common soft woods, among which yellow deal is classed, have a breaking strength when pulled asunder of 1 ton per square inch of area. When compressed they will withstand a similar pressure before collapsing (with short specimens).

The writer had three pieces of average deal, 3 feet 6 inches long by 2 inches by 2 inches section, tested to destruction as a column, and the following loads were registered :—

No. 1 collapsed at 9·4 tons.
No. 2 collapsed at 7·5 ,,
No. 3 collapsed at 7·1 ,,

The average breaking load being 8 tons or 4,423 lbs. per square inch of section.

These figures show that the various pieces of timber employed in the construction of the masts are of ample strength.

Bearing Pressure for Earth.—Ordinary soil at a depth of 2 feet will withstand a pressure of at least 1 ton per square foot of area.

The foundations given are, therefore, of ample size, and there is no need to insert a multitude of bricks, gravel or concrete, under the mast base.

When the anchor stakes have been inserted it is advisable to test them.

The average man can pull with a force equal to his own weight; a 10-stone man can, therefore, pull with a force of 140 lbs. Assuming only 1 cwt. pull, three men can exert a force of 3 cwts.

Each anchor should, therefore, be able to resist three men, pulling sideways or horizontally, without moving it from the ground; it will probably move an inch or so at the ground level, but that is immaterial.

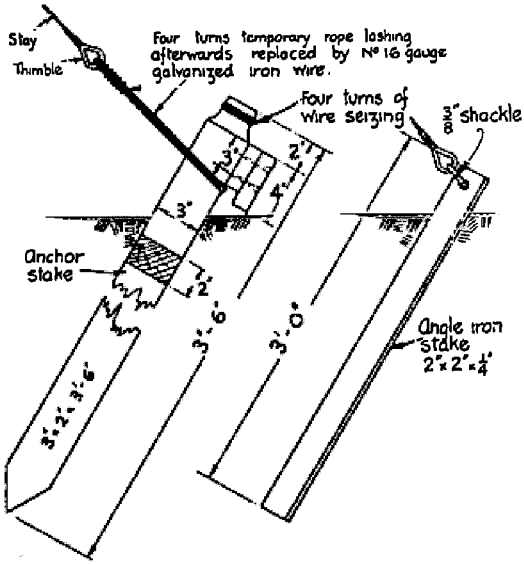


FIG. 7.—Anchor Stakes.

Should, however, the soil collapse and allow the stake to come out, the stake must be reinforced. Two short lengths of plank must be fixed across it as shown in Fig. 8, together with two or three bricks, and the soil well rammed, and test applied again.

The average ground or soil is termed hard or soft. Hard ground consists of gravel, stones, chalk, or limestone.

Soft ground, sand, loam, marl, or clay.

In hard ground, angle-iron stakes must be used for the anchors.

Loam is a mixture of clay and sand, and, when near the surface, is similar to garden mould.

Marl is a mixture of clay and stones.

In soft soils, except sand, use wood stakes for the anchors.

Concrete is a mixture of cement, sand and ballast (sharp stones, broken bricks or clinker).

Cement is sold in 200 lb. bags; the sand, by the load or half load, a load being called a yard, *i.e.*, a yard of sand.

Ballast can also be purchased by the yard, but generally sufficient stones, bricks or clinker are to hand. Do not use ashes.

With the use of wire netting little ballast need be inserted, three measures of sand being used.

The cement and sand are first thoroughly mixed dry in the proportions, one measure of cement with two measures of sand. Into this mixture add the ballast, three measures, which must not contain any pieces larger than 1½ inches across.

Sprinkle with water, and turn the mass over continually with a shovel.

Add water until the concrete is completely wet throughout, but stiff enough to stand up in a heap. Do not make it too wet so that the sand and cement run out.

The concrete must be mixed on boards, concrete or brickwork, and not on the ground so that earth or soil can mix with it. This is most important.

Directly the concrete is made it must be inserted in the mould, and rammed or puddled down with a stick to free it from air bubbles.

It is better to mix a small quantity at a time, and repeat the process, in order to fill one box, than to make too much and have some left over. This will be useless unless used in another mould at once.

Each mould must be filled up as soon as possible; do not half fill it and add the remainder the next day.

Allow forty-eight hours for the concrete to set, and then remove the box carefully by taking it to pieces. The process is then repeated for the other foundation blocks.

At least ten days must elapse before erecting the mast on the concrete, and preferably fourteen days.

If the weather is cold or frosty, well cover the blocks with earth and sacking, and never mix your concrete during frosty weather.

The blocks should be exposed to the air in fair weather; water or rain will not injure them.

Wind Pressure.—The duties of the masts are twofold, one

to support the aerial, the other to resist the wind pressure. In general practice, for masts of this height in the British Isles, 20 lbs. per square foot is taken for the wind pressure, except where the mast stands on a headland or prominent place.

The skeleton nature of the masts does not give a large wind area, the amount being about 10 lbs. per foot run of the mast, or 360 lbs. for a 36-foot mast. Approximately half of this is resisted by the mast foundation, when using one set of stays.

The four foundation stakes, driven 2 feet, therefore, have ample strength to resist any force that may arise in the horizontal direction (Fig. 19).

The main force exerted at the base of the mast is vertically downwards, due to its weight, and the vertical component of the stays and aerial halyard. These forces are resisted by the bricks. The side force at the base, due to the aerial pull, is practically absorbed by the aerial halyard and stays, and is almost negligible at the mast base.

Stay Anchors.—The amateur will find that fixing the stay anchors will probably be his most difficult task.

Few, possibly, possess a hammer of more than 7 lbs. weight, and, even if one happens to be available, it is no ordinary task to drive a stake in without splitting it. For those who propose to drive their stakes, *i.e.*, timber ones—iron stakes are, of course, driven—it is advisable to trim the top edges, and bind three or four turns of wire round, about an inch down ; this prevents splitting (Fig. 7).

In the absence of a heavy hammer, there is nothing for it but to dig a hole and insert the stakes. Undercut the ground, so that the soil against which the stake bears is not disturbed (see Fig. 8). When testing stake, pull against this face.

When filling in again a bucket of water will help the soil to settle, and a further layer of soil and a good ramming will complete the job.

Stays.—The most suitable material for the mast stays is flexible wire rope.

It is not advisable to use hemp rope, as this continually tightens up and slackens with weather conditions, causing the mast to be heavily stressed at one time, and unstable at another period.

The wire rope sold for ordinary clothes line meets the requirements well, it has ample strength, and is cheap. It is usually sold in 100-foot coils, which cuts up into three stays.

Insulators can be inserted in the stays if required, although they are hardly necessary for receiving stations.

In order to overcome the difficulty of splicing wire ropes, the method shown in Fig. 7A may be used. A sample was made up by the writer and tested. Failure occurred at the seizing at a tensile stress of 610 lbs. (5·45 cwts.).

This wire is, therefore, of ample strength for masts up to 36 feet.

The above test was carried out with wire rope sold at oil

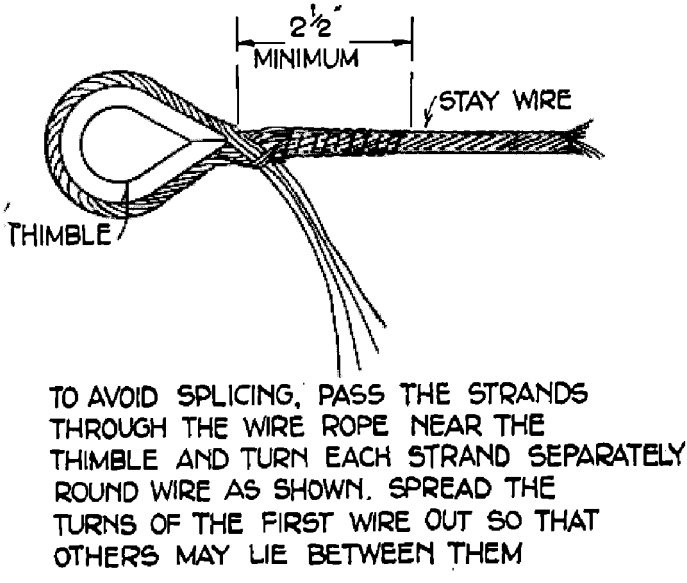

2½"
MINIMUM
STAY WIRE
THIMBLE
TO AVOID SPLICING, PASS THE STRANDS THROUGH THE WIRE ROPE NEAR THE THIMBLE AND TURN EACH STRAND SEPARATELY ROUND WIRE AS SHOWN. SPREAD THE TURNS OF THE FIRST WIRE OUT SO THAT OTHERS MAY LIE BETWEEN THEM

FIG. 7A.—Method of securing Thimble in Stay.

shops or ironmonger's for the ordinary household clothes line. It was 0·43 inches circumference and consisted of six strands, each No. 18 S.W.G.

Ship's chandlers are generally the best people to buy flexible steel wire rope from, and they can always give you its breaking load, which should not be less than 5 or 6 cwts., although they rarely stock a wire with a breaking load below half a ton.

It may be useful to mention that all ropes are measured by their circumference, and that thimbles for end connections

are called by the size of rope for which they are suited. Thus a 1-inch thimble fits a 1-inch circumference rope.

To facilitate handling of the stays during erection, it is advisable to cut them about 2 feet short, and use a 6-foot length of rope lashing at the end. Turnbuckles are not recommended. The stays may then be temporarily attached to their respective anchors and adjusted as required. The lashing is afterwards replaced by No. 16 S.W.G. wire, as shown in Fig. 7.

The various masts shown have three stays, set 120 degrees apart, but where climatic conditions are bad four stays should be used set at 90 degrees apart.

Strength of Wire.—Although the expression "galvanised iron wire" is frequently used, the wire is nearly always made of steel.

The breaking stress for small wires up to $\frac{1}{4}$-inch diameter is 55·000 lbs. per square inch for iron, and from 70·000 to 90·000 lbs. per square inch for the ordinary qualities of steel.

These figures give a breaking load for No. 16 S.W.G. of 172 lbs. for iron and 250 lbs. for steel. The writer purchased a piece of No. 16 S.W.G. galvanised wire at an ordinary ironmonger's for testing purposes, and the breaking load registered was 210 lbs.

No. 16 S.W.G. wire has been used in the self-supporting mast, as this size is most convenient to handle and gives sufficient strength. In the lower portion of the mast the necessary strength has been obtained by using two strands of No. 16 S.W.G. wire in preference to a wire of larger diameter and strength.

The following table, taken from a standard book, gives various sizes, strength and weight of wire :—

Standard wire gauge. No.	Weight per 100 ft. lbs.	Breaking stress in lbs. Iron.	Steel.
14	1·66	268	349
15	1·33	218	284
16	1·06	172	223
17	·80	131	170
18	·60	97	128
19	·40	67	87
20	·33	55	72

Site.—When the type and the height of the mast have been

decided, it is necessary to consider the place where the mast can be constructed, and left for a period during construction.

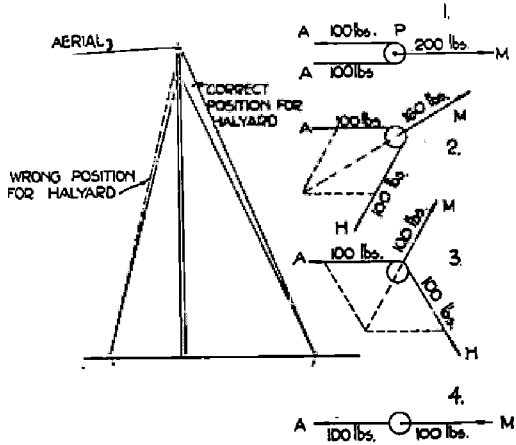
The length of space required must be slightly more than the height of the mast.

Generally the garden path will be most suitable, each individual deciding for himself.

The matter of level ground is of no consequence, and, using the clamps illustrated in Fig. 15, a level can soon be obtained.

Should flower beds or other objects intervene, make the clamp legs longer, so that the whole work stands clear of the ground.

The clamps should be 10 feet apart, and arranged so that



the finished structure rests in them and projects an equal distance either end. Also their position should be such that the completed mast can easily be moved to the erection site, so as to avoid having to go round corners.

The completed mast can easily be carried by two men.

Tools.—The minimum tools required are :—

Hammer.	Shifting spanner.
Wood saw.	Pliers.
Screwdriver.	Rule.
Gimlet.	Ball of string.

Other useful tools are a brace with suitable bits, screwdriver

bit, rose bit, square shank drills ($\frac{5}{16}$-inch, $\frac{3}{16}$-inch and $\frac{1}{8}$-inch diameter), and a heavy hammer.

It is a good plan to have a brace, as considerable time is saved in drilling holes and driving the screws, although a gimlet and screwdriver may be used as substitutes.

If no drills are to hand, it is not an expensive item to buy the necessary ones. This should be done, as a more satisfactory job is then made.

Halyards.—The aerial halyards may be of either hemp or wire rope, and of length equal to the height of the aerial attachment.

A spare length of rope is generally attached to the end of the halyard when it is necessary to lower the aerial, in order

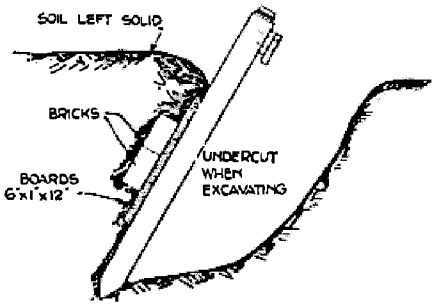


FIG. 8.—Reinforced Anchor Stake.

to avoid leaving the surplus length of the halyard coiled at the anchor stake.

When the aerial attachment is at a good height, and the halyard consequently long, it is sometimes necessary to have a down haul or a weight attached to the upper end of the halyard beyond the pulley or sheave, as the aerial may not be heavy enough in itself to overcome the weight of the halyard.

With masts supported by stays, the halyard may be brought to one of the anchor stakes (preferably the one furthest away from the aerial), or should an independent anchor stake be employed, it should be in line with the aerial, and on that side of the mast away from it. This method reduces the horizontal head pull at the mast head.

Always avoid, if possible, bringing the halyard down the mast, or in front of it under the aerial.

Figure shows the correct position for the halyard.

Sketches I, II, III, IV, illustrate the forces exerted at the mast head. See page 19.

A pulley, P, has a rope passed round it, and a force of 100 lbs. exerted at both ends. The arrows indicate the direction of the forces.

Let A represent the aerial pull.
Let H represent the halyard pull.
Let M represent the mast head.

Forces A and H are resisted or balanced by force M.

The halyard or force, H, is moved round in an anti-clockwise direction, and with each movement the mast force decreases in amount until, in Sketch IV, it equals the aerial pull.

The conditions in Sketch IV exist when the aerial is fastened direct to the mast and the halyard dispensed with. For general purposes the system in Sketch III is the best to employ.

When a pole is used on the roof as an aerial support, always endeavour to take the halyard over the roof away from the aerial.

Note.—When hoisting the aerial by means of the halyard, the final haul should be made by pulling hard with one hand only. This is approximately equal to a 50-lb. pull, and is sufficient for a single wire aerial.

When twin wires with a spreader are used, a little more force may be exerted.

Painting.—For outside woodwork, good red lead paint is always used for a priming coat. It is not sold ready mixed, but any oil and colourman will mix it up for you. However, it is quite simple to make up, and you then know that the right constituents are used. The proportions are :—

1 lb. of white lead (white sticky paste).
¼ lb. of red lead (vermillion powder).
⅓ pint boiled linseed oil.
½ pint turpentine.

The red lead powder is first ground into the white lead paste with an old knife. Do not allow this mixture to enter any cuts or abrasions of the skin in case blood poisoning is set up.

Equal quantities of boiled oil and turps are then added to thin the mixture.

Before putting on this priming coat of red lead paint, all knots should be covered with patent knotting, which can be

purchased from any oil and colourman, about an eighth of a pint is sufficient for a mast.

Two coats of ready-mixed paint can then be applied of the desired colour. When the finishing coat is to be white, use very little red lead powder, about a teaspoonful will produce a light pink as seen on the woodwork of new houses.

Maintenance.—Deterioration and corrosion of a material is due to continual changes of temperature, that is, alternate changes from warm and dry conditions to dampness.

If the material is always dry or always wet, its life is longer.

It is, therefore, natural to expect rotting and decay in woodwork at the ground level, and a few inches down. For this reason the masts have been designed to stand on brickwork above the ground, so that the foundation posts can easily be renewed when necessary.

An examination of the mast foundations and anchor stakes should be carried out each year. The tar scraped away at the ground level and for 6 inches down. The exposed wood is then chipped away with a knife or chisel to test its soundness. If it is hard and brittle, as in its original state, it may be left for another year, but should softness or pulp be discovered this must all be cut away, the clean wood exposed, and then well tarred. If this decay extends into the wood $\frac{1}{4}$ inch, the member must be removed and a new piece inserted.

The wood masts will have a life of at least five years, providing they are given a fresh coat of some preserving material at intervals.

Before erection, three coats of paint should be applied, and at least two coats of creosote put on freely.

The mast need not be given another coat for two years, but after that it should be painted annually.

The stays and their attachments also need inspection, but being of wire they will easily outlast the mast.

The only point to watch with regard to them, is rubbing, chaffing or cutting through at attachments.

Gas Barrel.—For a wireless mast the most suitable tubing is gas barrel. It can be purchased from a general ironmonger's or builders' merchant, although it is the better plan to order it through a plumber or gas-fitter, as they can cut it to length, screw and attach the necessary fittings.

Pipes of this character are measured by their inside diameter or bore. Thus a 2-inch gas pipe has an internal diameter of 2 inches, and all fittings for this particular pipe are called

2-inch gas, *i.e.*, nut for 2-inch gas pipe, socket for 2-inch gas pipe, etc. The threads are also termed 2-inch gas.

The following table gives the size of various tubes :—

Bore of tube. Ins.	Outside diameter to nearest $\frac{1}{16}$ in Ins.	Threads per in.
1	$1\frac{5}{16}$	11
$1\frac{1}{4}$	$1\frac{1}{16}$	11
$1\frac{1}{2}$	$1\frac{7}{8}$	11
$1\frac{3}{4}$	$2\frac{1}{8}$	11
2	$2\frac{3}{8}$	11

CHAPTER III

SCAFFOLD POLE MASTS

SCAFFOLD poles can be obtained from any builders' merchant and sometimes from a local builder, but in the latter case they may be fairly old and not very long, so that it is a better plan to go to a builders' merchant and obtain a new one.

Ordinary scaffold poles range from 20 to 28 feet in length, although it is possible to obtain them up to 40 feet at a price. New poles can easily be detected by having the bark practically intact. Old poles are generally minus the bark, and of a greyish colour.

At the butt they measure about $4\frac{1}{2}$-inch diameter, and taper to $2\frac{1}{2}$-inch diameter at the top. No pole should be selected under these dimensions when exceeding 25 feet in height.

Thirty-foot poles should be 5-inch diameter butt and 3-inch diameter top.

Thirty-five-foot poles, 6-inch and 3-inch diameter.

Before erecting one the bark must be scraped off, and the pole either painted or given a coat of creosote. The butt must be well tarred for at least a foot above the ground.

Fig. 1 illustrates the general arrangement of a scaffold pole mast complete. It is supported by three stays, set 120 degrees apart, and the butt buried 3 feet in the ground.

The aerial sheave at the head of the pole may be let in, as shown, and should be 3-inch diameter, the recess being wide enough to just admit it, thus leaving no space for the aerial halyard to ride off the sheave, and jam.

The mast cap serves two purposes : it prevents the weather affecting the top of the pole and braces the split end together.

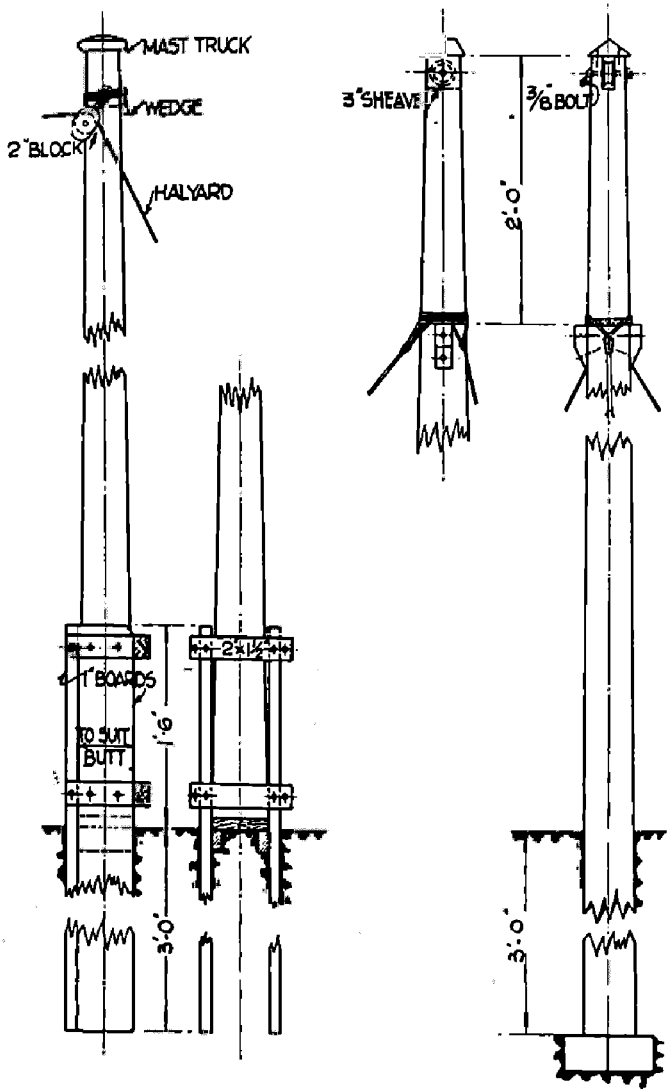


FIG. 1.—Scaffold Pole Mast.

A round mast truck can be purchased, but an ordinary piece of wood is sufficient.

Room must be left between the sheave and cap to allow the end of the halyard with a thimble spliced in to pass.

The stays are attached, 1 foot down the pole, by taking two or three turns round with the wire and seizing the end back on itself.

A wedge can be inserted, if necessary, to tighten the strands.

Fig. 1 shows an alternative arrangement for the base. One advantage being, 3 feet of length is saved and given to the height for the same pole.

The housing consists of boards 1 inch thick, with internal dimensions equal to the diameter of the butt.

One face of the housing is left open, so that the pole may be raised up in the housing, and two wood bars are then secured across it.

Sometimes a bolt is used in the housing as a hinge on which to raise the pole; in this case, a wedge or packing must be inserted under the butt to take the weight of the pole.

An alternative arrangement is shown for attaching the halyard block. Note the use of a wedge for the seizing.

CHAPTER IV

PLANK MASTS

THE plank mast is the alternative to a wooden pole, and has the advantage of being possibly cheaper, equally as strong, and is quite easy to build up.

The mast is supported by three stays, equally spaced (Fig. 2), with the base sunk in the ground. It is rectangular in section, and built up with boards and battens, as shown in Figs. 3, 4, 5, 6.

The various pieces of timber are secured together with No. 10 wood screws, 2½ inches long. Other lengths may be used, but these are most convenient for driving and give sufficient strength, provided the inner battens are screwed together at intervals.

The minimum number of coach-bolts are shown consistent with strength, but additional ones may be added at intervals.

At the mast base and mast joint the section is solid, the

battens being replaced by boards. The mast head is also solid, but one of the packing boards is 4 inches short to allow access for the aerial sheave.

The sheave can be purchased at an ironmonger's, and any

PLANK MAST.

MAST-HEIGHT	STAY HEIGHT	STAY BASE	SITE WIDTH	SITE LENGTH	MAST SECTION	TIMBER IN SECTION
FEET	H	$\frac{H}{2}$	W	L		
20	18'-0"	9'-0"	15'-8"	13'-6"	4½" 3"	FOUR 4½" × ¾" BOARDS
25	22'-0"	11'-0	19'-2"	16'-6"	4½" 4"	TWO 4½"×1" BOARDS FOUR 2"×1" BATTENS
28	26'-0"	13'-0"	22'-8"	19'-6"	6" 4"	TWO 6"×1" BOARDS FOUR 2"×1" BATTENS
32	30'-0"	15'-0"	26'-0"	22'-6"	6" 6"	FOUR 6"×1" BOARDS FOUR 2"×1" BATTENS

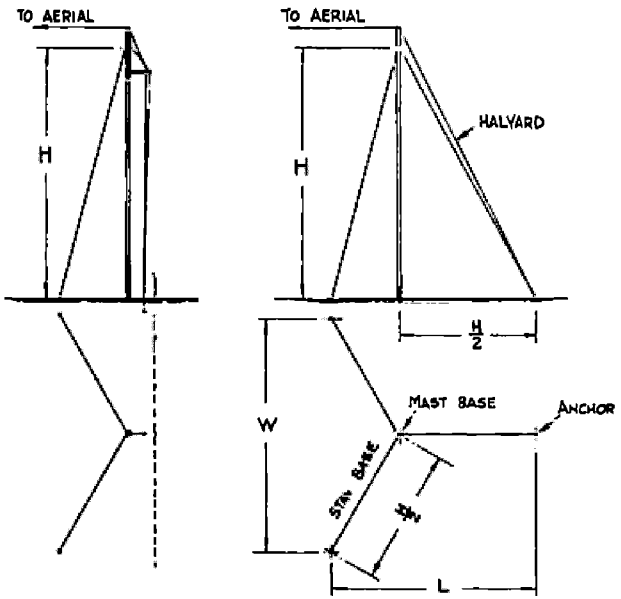


FIG. 2.—Plank Mast, Diagram and Table.

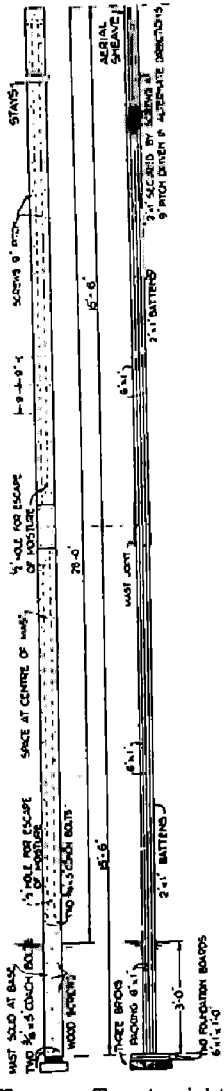


FIG. 3.—Twenty-eight foot Plank Mast.

space on either side of it should be filled in with wood, to prevent the aerial halyard riding off the sheave.

The faces of the timber in contact do not form watertight joints, therefore it is necessary to drill a hole, just above each solid section, to allow moisture to escape which may form or collect in the interior of the mast.

The timber should be well creosoted with two coats, and the base of the mast well tarred for at least 4 feet up.

It is also a good plan to tar the screw heads after they are driven in, and apply a little oil before driving each screw home.

The anchor stakes are illustrated in Fig. 7. They must be well tarred, and the stays secured with wire lashing, as previously explained for the lattice mast (Chapter II.).

The aerial halyard should be brought to the ground in line with the aerial, and on that side of the mast away from it.

Erection.—The completed mast has no great weight and can easily be handled.

Dig the foundation hole, and insert the foundation board on two or three bricks, lie the mast base over this, and spread out the stays to their respective anchors.

Two men then lift the upper end of the mast and walk towards the base, raising the mast above their heads, the

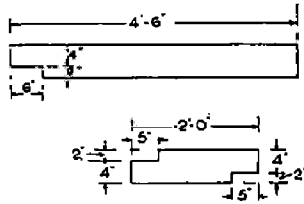


FIG. 4.—Joint and Base Packing.

stay men assisting to pull it vertically, by means of the stays (see Fig. 9).

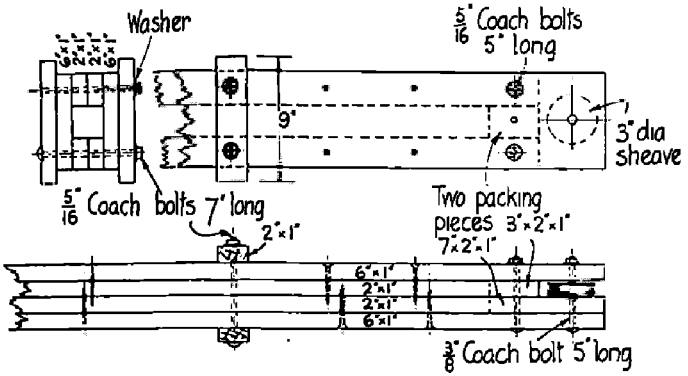


FIG. 5.—Detail of Head.

When nearly vertical, one of the men, who has been pushing the mast up, goes to the third stay to check it.

The stays are now temporarily attached, and the mast lifted

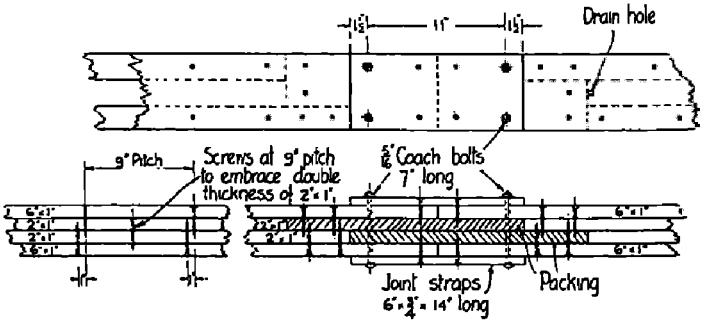


FIG. 6.—Detail of Joint.

on to its foundation board, finally secured and the soil rammed in.

Remember to have the aerial halyard correctly rigged before raising the mast, and set the mast in such a position that its greater width of section is in line with the aerial.

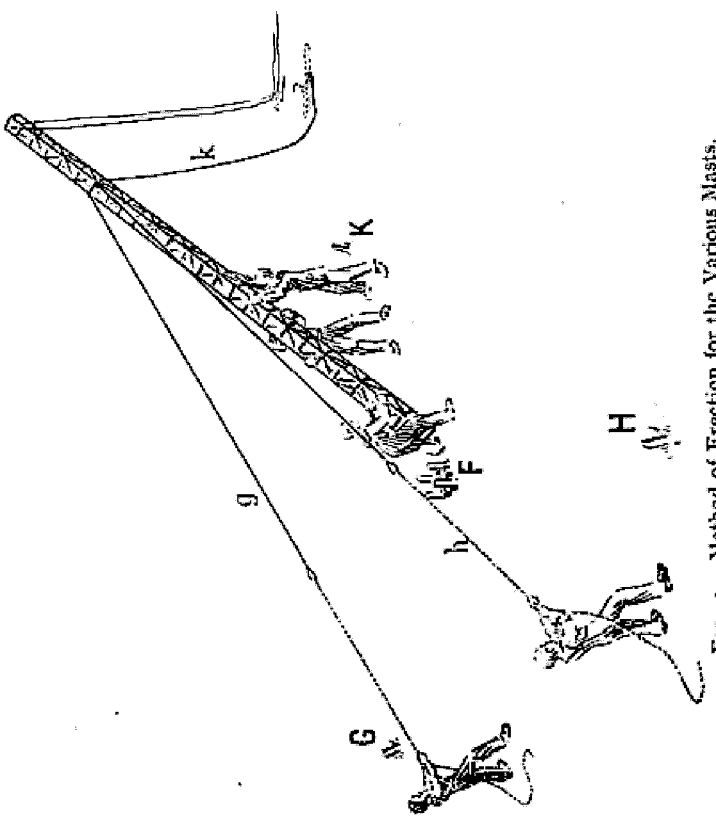


FIG. 9.—Method of Erection for the Various Masts.

The method of erection of lattice mast should also be consulted.

When the base of the mast is to be near the garden fence or other object, and a strut is used for the back stay as in Figs. 2 10, 11, the method of erection must be modified (Fig. 12).

The mast is raised and pushed up by two men, while the

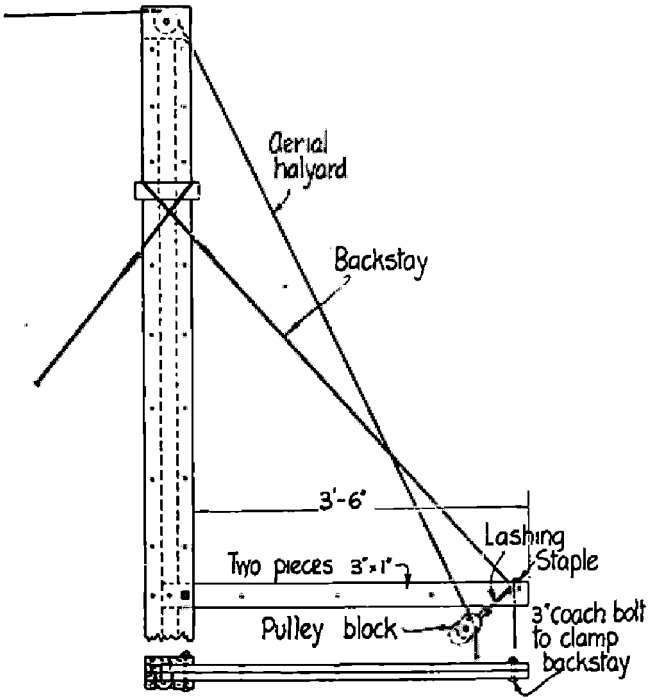


FIG. 10.—Back Stay Strut.

two stay men steady it sideways by means of the stays. When nearly vertical, the two stays are attached to their anchors, and the mast allowed to go over the vertical. It is then held by the two stays already secured, while the back stay is made fast. The three stays can now be adjusted and the mast brought vertical.

The sections and timber required for the different heights

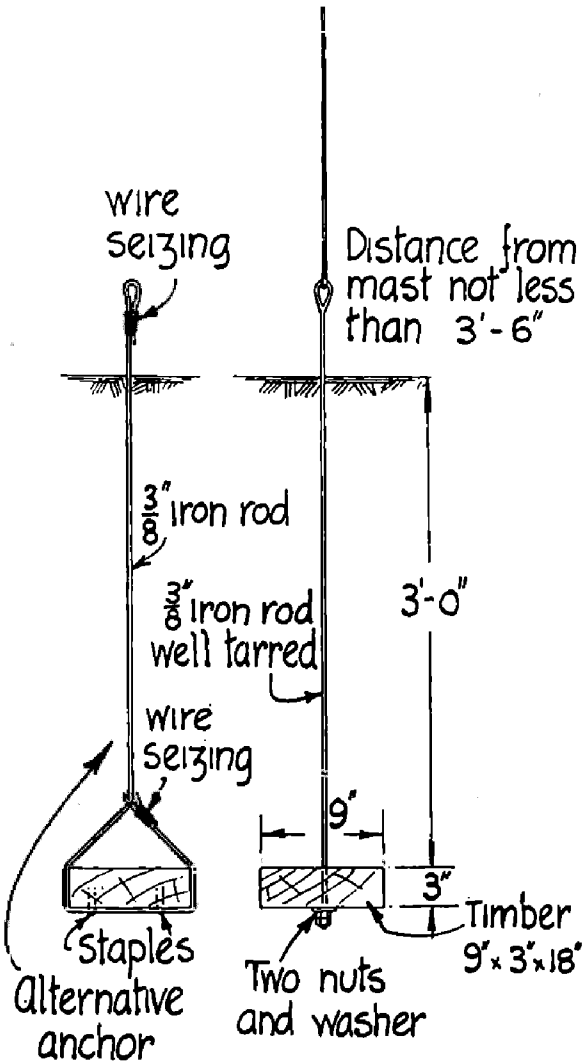


FIG. 11.—Back Stay Anchor.

of mast are shown in Fig. 2. The arrangement for the base, the mast joint and aerial sheave being similar to that shown in the drawing.

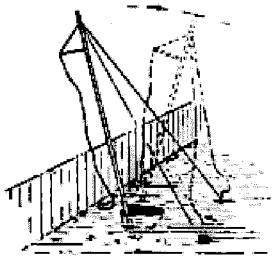


FIG. 12.—Erection near a Fence.

A table of quantities for a 28-foot Plank Mast is given below.

QUANTITIES FOR 28-FOOT PLANK MAST.

Description.	Number required.	Length.	Size of Timber. Ordered.	Size of Timber. Received.	Feet run ordered.	Remarks.
		ft. in.	in.	in.		
Outer planks	4	14 0	6 × 1	6 × 1	56	unplaned
Inner battens	4	13 0	2 × 1	1⅞ × ⅞	52	
,, ,,	4	9 0	2 × 1	1⅞ × ⅞	36	
Joint strap	2	1 2	6 × ¾	6 × ¾	3	unplaned
Joint packing	2	2 0	6 × 1	6 × 1	4	,,
Butt ,,	2	4 6	6 × 1	6 × 1	9	,,
Sheave ,,	1	1 0	6 × 1	6 × 1	2	,,
Base board	2	1 0	6 × 1	6 × 1	2	,,
Stay bar	2	0 9	2 × 1	1⅞ × ⅞	2	,,
Coachbolts	6	⅜ × 7	with nut and washer.			
,, ,,	6	⅜ × 5	,,	,,		
,, ,,	1	⅜ × 5	,,	,,		
Wood screws, iron	1 gross	2½ in.	No. 10			

Approximate cost of above material 20/-.

CHAPTER V

STAYED LATTICE MAST

THE general design and details for this mast are shown in the accompanying drawings, which are self-explanatory.

The structure is of lattice work, 36 feet over all in height, with a 12-inch square section, and consists of four leg members, set at the corners of a square, braced together with horizontal and diagonal members on each side face. It is made in three sections.

The whole structure is supported on its foundation by means of three wire rope stays suitably attached, and an aerial halyard is reeved through a pulley attached at the head of the mast.

This type of mast requires a certain amount of ground space for the stays which is shown in Fig. 13. Where possible, these dimensions should be adhered to, but a variation not exceeding 1 foot may be made in any one of them.

The construction can proceed directly the height has been decided upon, and timber purchased accordingly (see Table of Quantities, page 44).

First select four battens for the leg members, and mark them off as shown in Fig. 14. The timber having been previously creosoted.

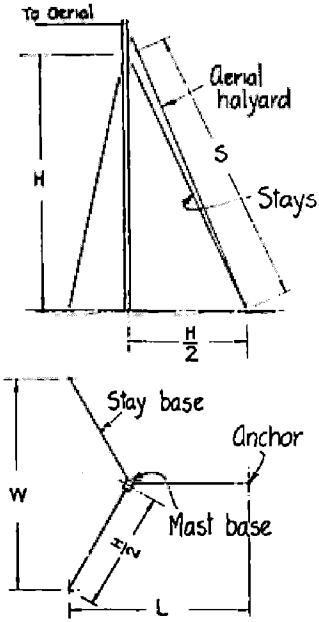
The four ends are kept flush and marked A, B, C and D. The first pencil mark is 3 inches from the end, and subsequent ones at 1 foot—1¾-inch intervals. Now turn the four members each over one face and mark again, this time the first mark is 3½ inches from the end and the others at 1 foot—1¾-inch intervals. This staggering of the marks, against which the horizontal struts are placed, prevents the screws meeting in the leg members at connections.

Next cut the horizontal struts to size, cut the first one accurately, and use this as a template for marking off all the others; this obviates magnifying any error in length. The struts are then given a coat of creosote, together with the diagonal members.

At $\frac{11}{16}$ inch from each end of the horizontal struts, drill a $\frac{3}{16}$-inch diameter hole, and also a $\frac{3}{16}$-inch diameter hole $\frac{3}{4}$ inches from each end of the diagonal members.

Now place two leg members, A and B, 12 inches apart in the clamps, keeping the two ends in line. Place the horizontal

struts so that their upper edge is at the pencil marks, and their two ends flush with the sides of the leg members. With a sharp instrument inserted in the hole in the strut, mark the



MAST HEIGHT	STAY HEIGHT	STAY BASE	SITE WIDTH	SITE LENGTH	STAY LENGTH MAST TO ANCHOR
	H	$\frac{H}{2}$	W	L	S
25'-0"	20'-0"	10'-0"	17'-4"	15'-0"	22'-6"
30'-0"	25'-0"	12'-6"	21'-8"	18'-9"	28'-0"
36'-0"	30'-0"	15'-0"	26'-0"	22'-6"	33'-9"
42'-0"	36'-0"	18'-0"	31'-3"	27'-0"	40'-6"

NOTE: FOR 42FT. MAST, WIDTH OF MAST SECTION MUST BE INCREASED TO 15" SQUARE FROM 12" SQUARE AND HORIZONTALS 1½" x ¾" INSTEAD OF 1" x ¾".

FIG. 13.—Stayed Lattice Mast. Diagram and Table.

leg members, then drill them with $\frac{1}{8}$-inch diameter drill right through at all these marks.

The drilling may seem tedious, but it saves time and labour

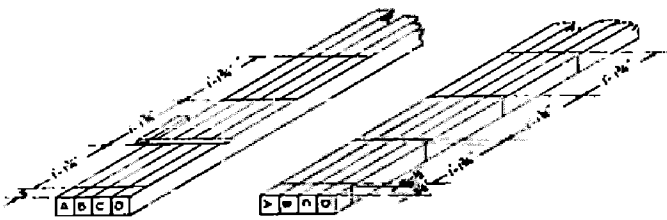


FIG. 14.—Marking off Leg Members.

when driving the screws—there are plenty of them—if properly done with the right-size drills.

The struts may now be secured in position, all the screws being given a drop of oil before driving them in.

The frame now formed must be set in the clamps and the

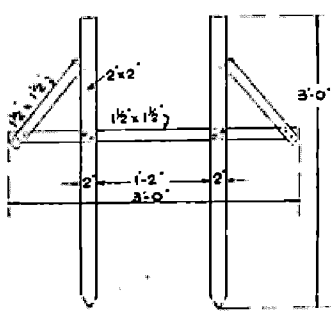


FIG. 15.—Clamps.

lower ends set in line with each other. This frame forms one side of the lower section of the mast, so that only the lower ends of the legs can be made flush as the upper ones are staggered for the joints.

Before marking off the holes for the diagonal members the frame must be tested for straightness by means of a string line along one edge. Deflection downwards does not matter at

this stage, but if bent sideways, the frame must be pushed straight and a peg driven into the ground to hold it in this position. Now secure one diagonal, this will lock the frame, and then proceed to mark off and secure the others.

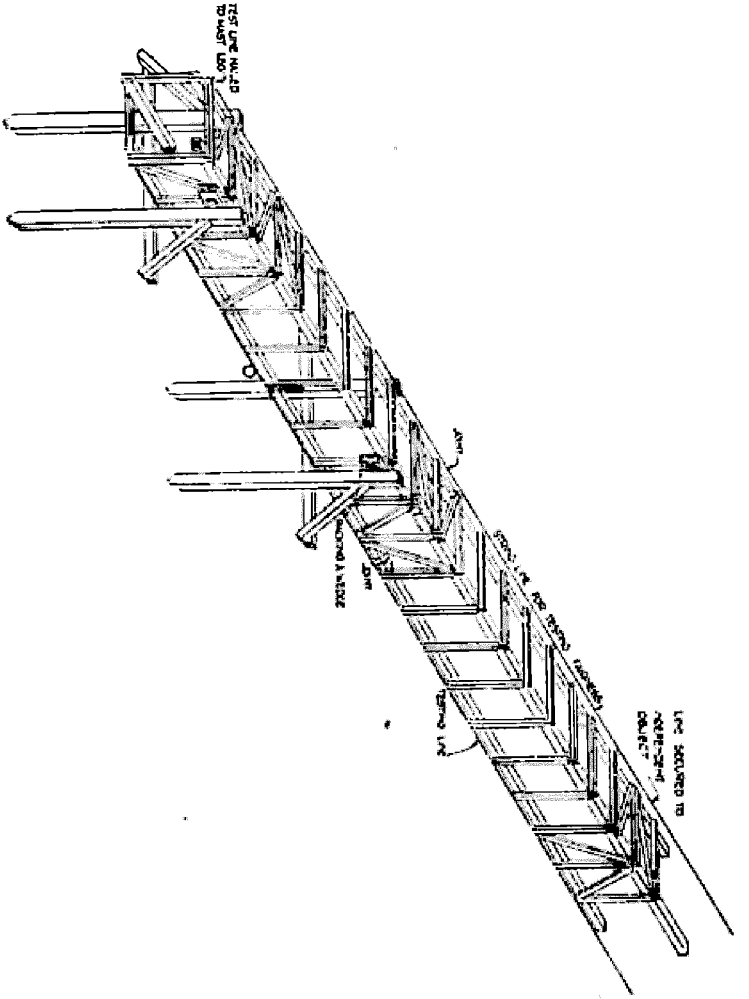


FIG. 16.—Showing Construction of Mast.

The leg members, C and D, are connected in a similar manner, and two side frames for the lower section of the mast are completed. Place these two frames 12 inches apart in the clamps, standing them on one edge with the bracing outwards, that is, leg A above B, and D above C. Secure the horizontal struts on this face, A D, and then turn the framing over so that

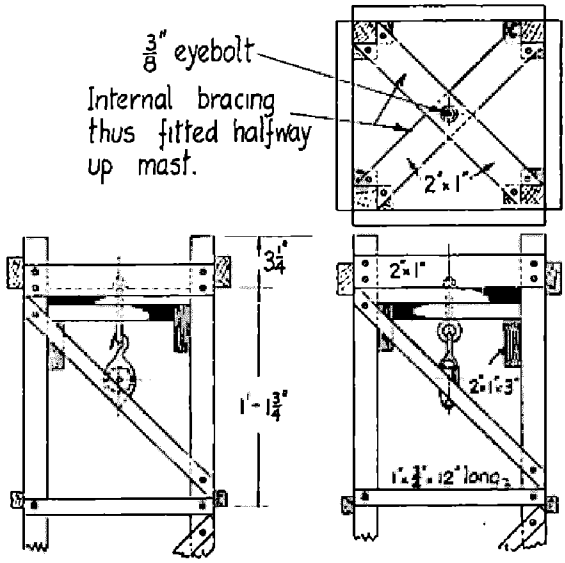


FIG. 17.—Aerial Attachment at Mast Head.

face B C is upwards, again secure the horizontal struts, then set the lower ends of the legs in line, test for straightness with string, as shown in Fig. 16, make framing true if necessary, and mark off and secure the diagonals.

The remaining diagonals on face A D are then fixed, after frame has been tested and made true if necessary.

This completes the lower section of the mast, the middle and upper sections are built up in a similar manner, and provision is made for the stay connection and aerial attachment as shown in the drawing, Figs. 17 to 24.

The next process is joining the sections together, first prepare the joint straps and drill as shown in Fig. 21. The

straps are $1\frac{1}{2} \times \frac{3}{4} \times 9$ inches long, and each leg is joined together by means of two straps one on either side, the screws being staggered as shown to clear each other. One section of

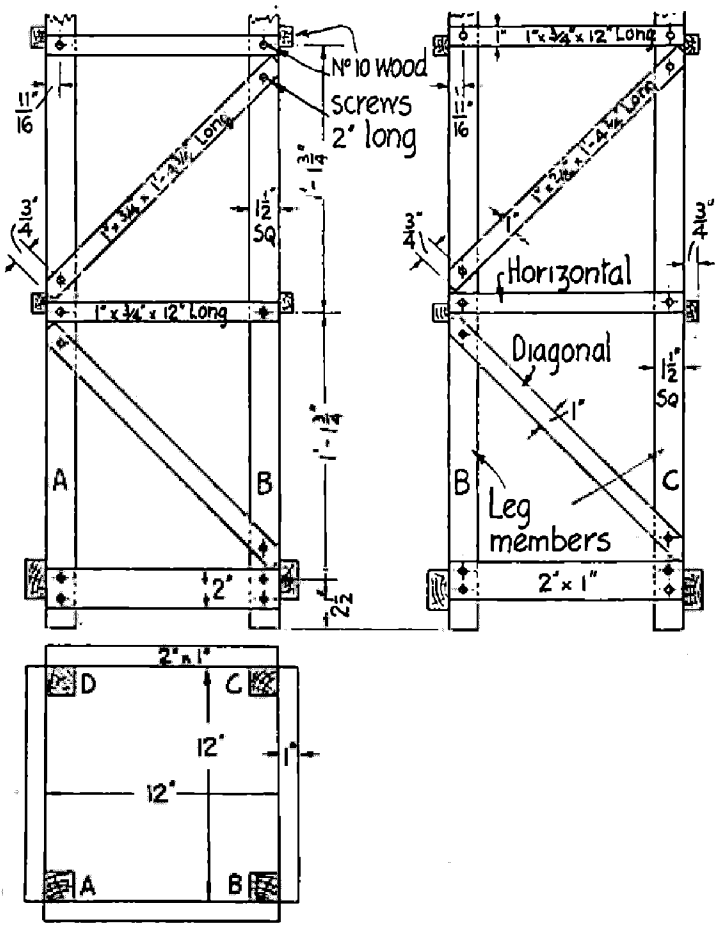


FIG. 18.—Lower Portion of Mast.

the mast is secured in the clamp, and another section placed end on and packed up level. The test line is then applied, and the two sections made to butt at the legs and trued up.

Probably only two leg members will butt, say AA, the space existing between the others being $\frac{1}{8}$ inch B, $\frac{1}{4}$ inch C, $\frac{3}{8}$ inch D.

Leg A must be shortened $\frac{3}{8}$ inch; B, $\frac{1}{4}$ inch; C, $\frac{1}{8}$ inch; D, o. Saw the respective amounts off one leg member at each joint, allowing for the thickness of the saw cut. Now draw one section up, so that all four legs butt, and test for fairness with string line, ease any leg that may still require it, and

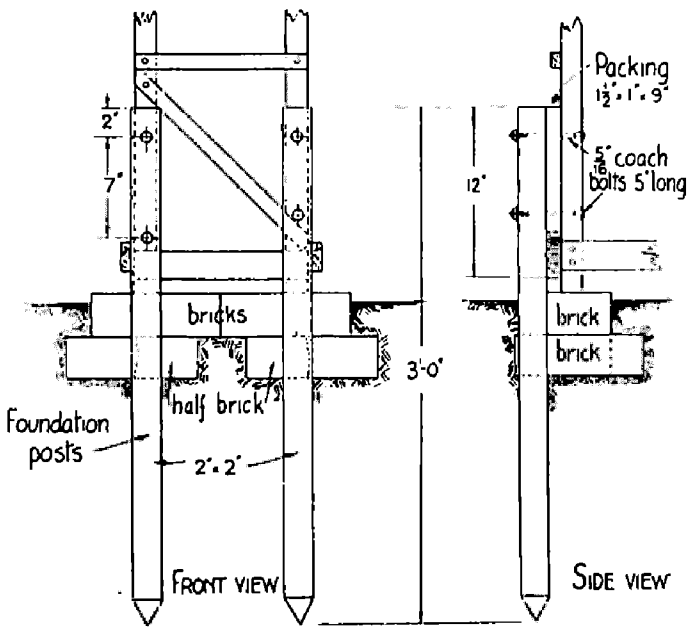


FIG. 19.—Mast Base.

proceed to secure joint straps and remaining struts and diagonals.

The joints are shown in different planes or positions, and it is advisable to adhere to this method and not make them all in the same position.

The remaining section of the mast is joined in the same manner and two test lines used over the whole length of mast, one on the upper face and one on a side face. The structure is then completed.

Erection of Mast.—Although the mast can be raised into the vertical position in a few minutes, it is not advisable to do so

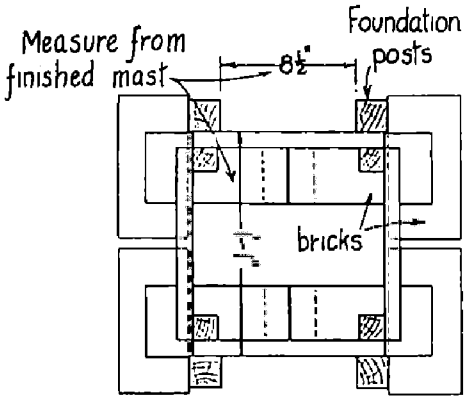


FIG. 20.—Foundation Plan.

unless you have two or three hours to spare in which to devote to the mast after it is up.

The anchor stakes are first driven in, and the foundation

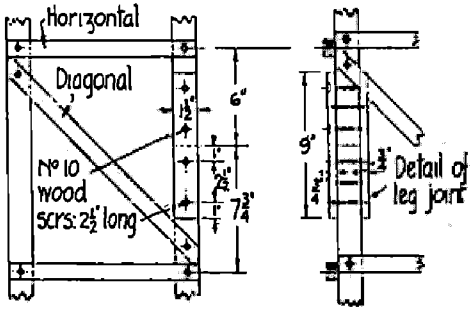


FIG. 21.—Leg Joint.

made up. Six or eight bricks are buried just below the surface of the ground, and four more are placed above these to receive the four mast legs (Fig. 19).

The foundation stakes are then drilled and driven in, the

distance between them being the same as the mast base, approximately 1 foot 1 inch and 8½ inches, as shown in Fig. 20.

The mast will be raised in one direction according to space available, but the width of 1 foot 1 inch should be in line with the aerial.

The base of the mast is then placed near the foundation, not on it, in such a way that the aerial pulley and halyard will be the correct way round when the mast is up.

Take each stay to their respective anchors (Fig. 13) and see that aerial halyard is fitted.

Two men raise the head of the mast, one man stands at the base, and two other men take a stay each (Fig. 9). The

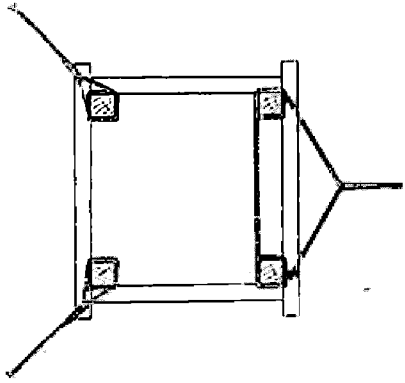


FIG. 22.—Stay Connection.

corner of the base on which the mast swings up rests on the soil in front of the bricks, so that when vertical the mast stands on the ground and not half on and half off the bricks.

The two men raising the mast walk towards the base, lifting it above their heads as they go. When the masthead is about 10 feet clear of the ground the two stay men help to haul it up. When nearly vertical one of the mast men goes to the back stay to check the mast. The position is now, two men at mast base and one man on each of the three stays. The stays are now temporarily secured to the anchor stakes, not quite taut, and the mast is lifted on to its foundation bricks, and set between the foundation posts; it is then sited with

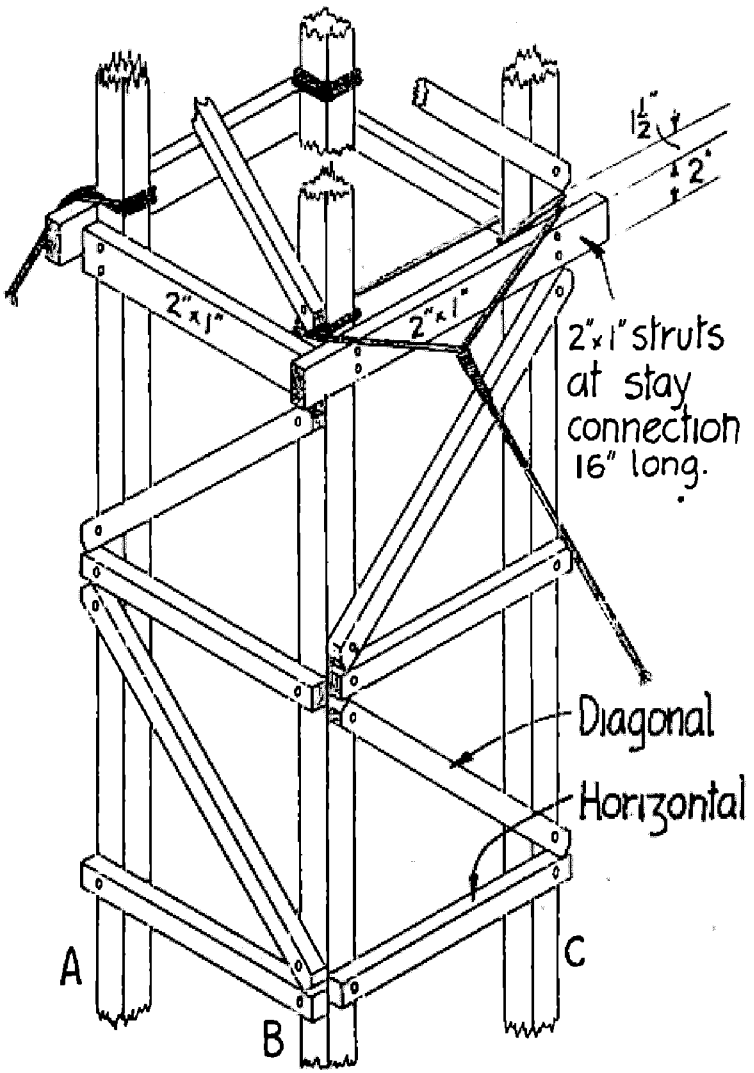


FIG. 23.—General View at Stay Connection.

some distant object for the vertical, such as the side of a house, and the stays made taut. The foundation bricks being levelled up or wedges driven in as required.

The mast legs must now be drilled to correspond to the bolt holes in the foundation stakes, and the whole bolted up.

The use of lashing at the lower end of the stays is only a temporary measure. It is easy to handle, and the wire is not twisted or kinked with the various adjustments of the stays.

It will be found that the stays stretch slightly, also the rope lashing, and that the mast will settle down on its foundation ; all this causing the stays to slacken. It is, therefore, necessary to adjust them once or twice at first, and during the next day, after which the rope lashing can be replaced by wire and a lower insulator inserted if desired.

After the mast has been erected it will appear much longer than it did when lying on the ground, and may give rise to anxiety for the owner, but, providing the anchor stakes are as shown in Fig. 7 and the stays of wire rope as specified, no fear need be felt for its stability.

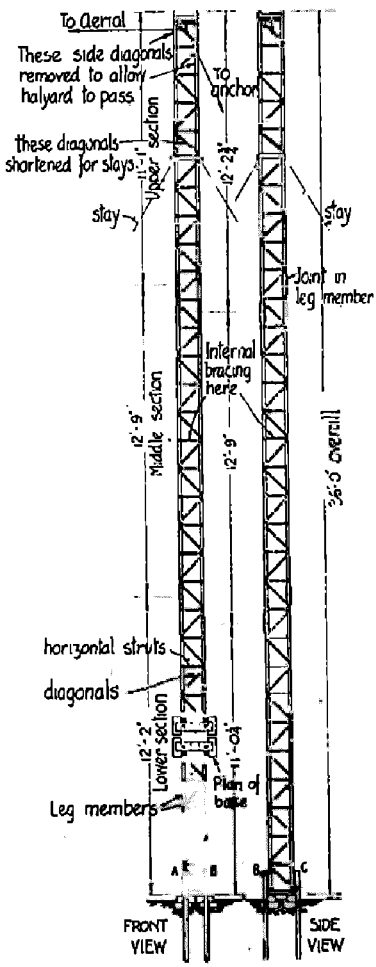


FIG. 24.—General Arrangement Stayed Lattice Mast.

TABLE OF QUANTITIES. STAYED LATTICE MAST, 36 FEET HIGH.

Description.	Number required.	Size of Timber. Ordered.	Size of Timber. Received.	Feet run ordered.	Remarks.
		Inches.	Inches.		
Leg members, A, B, C, D	12 lengths.	1½ square.	1⅜ square.	150	Cut as drawn.
Struts	116 pieces	Hold up to			
Diagonals	124 ,,	1 × ¾	1 × ⅝	300	,, ,,
Stout struts	12 ,,	2 × 1	1⅞ × ⅞	12	,, ,,
Internal bracing	4 ,,	2 × 1	1⅞ × ⅞	6	,, ,,
Anchor stakes	3 ,,	3 × 2	2¾ × 1⅞	11	,, ,,
Foundation posts	4 ,,	—	—	12	Use clamp posts when finished with.
Foundation packing	4 ,,	2 × 1	1⅞ × ⅞	4	
Clamp posts	4 ,,	2 square.	1⅞ square.	12	Cut as drawn.
Clamp members	6 ,,	1½ square.	1⅜ square.	12	,, ,,
Iron wood screws	480	—	—	—	No. 10 gauge, 2 inches long, 3½ gross.
Stays, flexible wire rope	100 feet.	—	—	—	Six strands No. 18 gauge wire.
Halyard	Height of mast (independent of structure)				
Aerial pulley	1	—	—	—	Galvanised iron.
Aerial eye bolt	1	—	—	—	With nut and washer.
Foundation bolts	8	—	—	—	⅞ inch diameter coach-bolts, with nut and washer, 5 inches long.
Creosote	—	—	—	—	One gallon.

Approximate cost of material 30/-.

CHAPTER VI

SELF-SUPPORTING MAST

THIS type of mast meets the requirements of amateurs who are limited to space for the stays.

The general arrangement of the structure is shown in Fig. 25, and consists of four leg members, horizontally braced with wood struts, and tied diagonally with galvanised wire, the whole tapering from the base to the head of the mast.

The design is arranged for two different heights, 35 feet and 28 feet 6 inches respectively.

The reduction in height being obtained by omitting the two lower bays from the design shown for the 35-foot mast.

The mast foundations are shown in both concrete and timber to suit personal requirements, also a suitable arrangement is shown for the aerial attachment.

All information with regard to the material required for the construction of this mast is given in Chapter II. The necessary quantities of material are given in Table (page 53).

The mast is constructed in three sections, the lengths being 11 feet, 12 feet 11 inches, and 11 feet 1 inch.

The table of quantities gives the length and sizes of the various members and Fig. 27 shows the method of connecting the wire ties.

In bays *a* to *e* the wire ties are double, *i.e.*, two strands of No. 16 gauge wire, in bays *e* to *o* the ties consist of a single strand.

First select two pieces of timber for

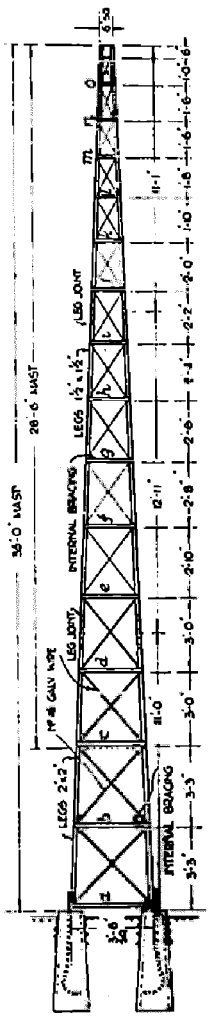


FIG. 25.—General Arrangement Self-supporting Mast.

the lower leg members, and mark them off for the horizontal struts as previously explained for the stayed lattice type (Fig. 14). Attach the horizontal struts, leaving $\frac{1}{8}$ inch clear for the wire ties between the strut and leg members.

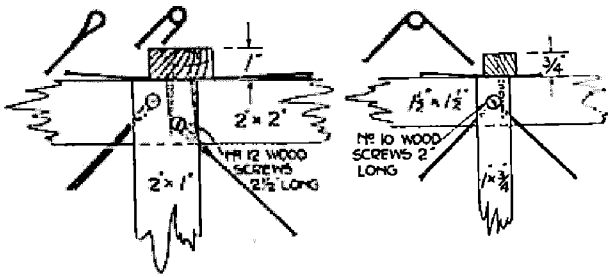


FIG. 26.—Method of Attaching Wire Ties.

The side frame thus formed must be set and secured in the clamps (Fig. 15), with the lower ends of the leg members in line.

The next process is to secure the wire diagonals. Cut a

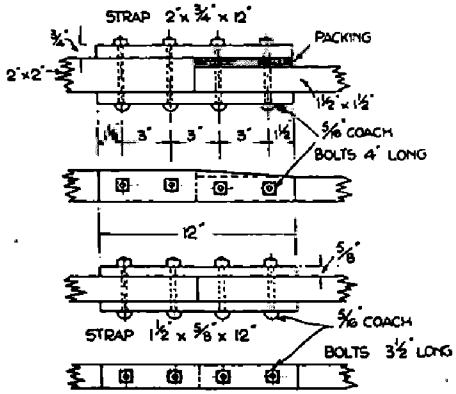


FIG. 27.—Detail of Joint in Leg Member.

length of wire 10 feet long and form a loop at one end round the screw in the lower horizontal strut, as shown in Fig. 26.

Now pass this wire round the screw on the opposite leg member in the horizontal strut immediately above.

The wire is passed round this screw with one complete turn, in a clockwise direction, and then brought back along itself to the screw, to which it was first attached ; now turn the wire

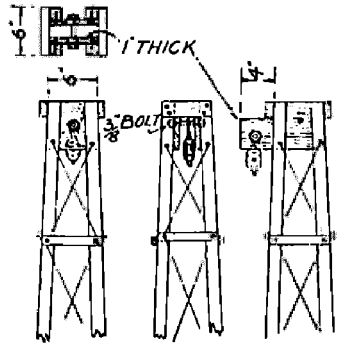


FIG. 28.—Aerial Halyard Attachment.

round this screw and seize the end round the two strands as shown in the figure.

Each wire diagonal must be taken round the screws in a

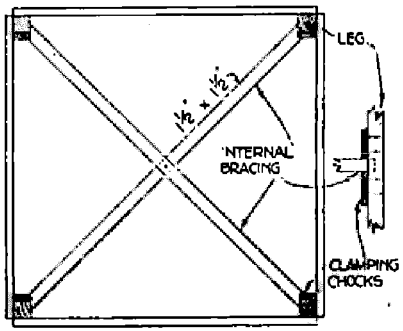


FIG. 29.—Internal Horizontal Bracing.

clockwise direction so that the action of driving the screw home tends to tighten the wire.

The various strands of wire must be held taut with a pair of pliers while they are turned round each screw, but it is not essential to place a heavy initial load in the wires.

Care must be taken to keep the frame true, with the lower ends of the leg members in line, when fixing the first diagonal.

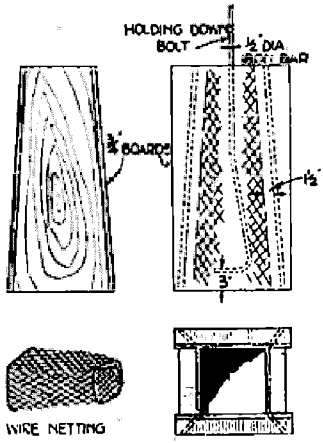


FIG. 30.—Mould for Concrete Foundation.

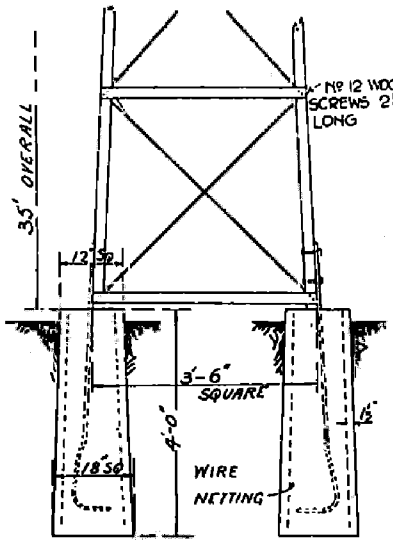


FIG. 31.—Foundation for 35-foot Mast.

After this is in position and secured, the frame is locked and cannot be readjusted without removing the diagonal wire.

The remaining diagonal wires can now be inserted in this side frame to complete it.

Another side frame is completed in a similar manner and forms the opposite face of the lower portion of the mast.

The two side frames, thus formed, are set in the clamps as explained for the stayed lattice type, so that the bracing on the third and fourth sides can be placed in position and secured.

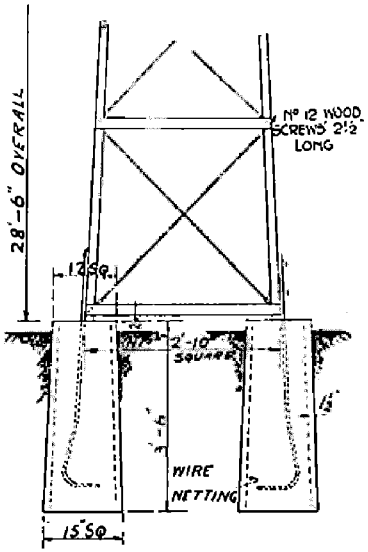


FIG. 32.—Foundation for 28-foot 6-inch Mast.

As the mast tapers, a certain amount of packing must be used in the camps to secure the framing, and the test lines brought down the middle of two adjacent sides and not along the leg members.

The middle and upper portions of the mast are built up in a similar manner and joined together, the butting of the leg members at the joints being carried out as described for the stayed lattice type (page 37).

It is a better plan to have the joints staggered, but this

complicates construction. The joints may therefore be in the same plane, provided that the joint straps are securely fastened with coach-bolts as shown in Fig. 27.

The aerial attachment is fully illustrated and needs no comment. Where possible, the halyard should be brought to the ground on the side of the mast away from the aerial, but an alternative arrangement is shown for the halyard down the side of the mast.

The internal horizontal bracing shown in Fig. 29 is fitted at sections marked *b* and *g*, Fig. 25.

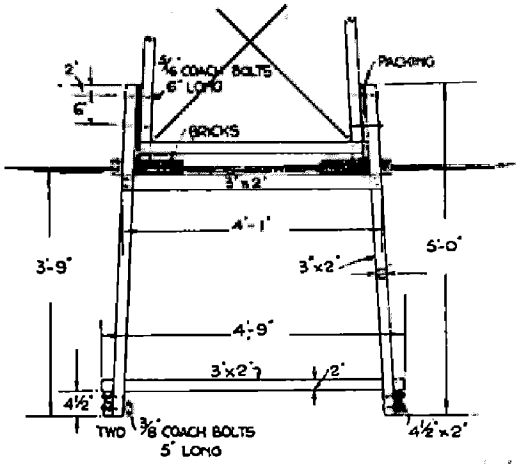


FIG. 33.—Timber Foundation.

The diagonals are locked in position on the leg members by means of chocks as shown in the figure.

Mast Foundation.—Two designs are shown, timber and concrete.

For the timber foundation an excavation must be made in the ground and a framing built up as shown in the figure. Well tar the timber.

The soil is replaced and well rammed down. This should be done a day or two before erecting the mast, and the soil watered so that it settles firmly.

Measure the width of the mast base over the side struts and build the foundation framing to suit. Make the dimensions

between the corner posts sufficient to clear the leg members of the mast, and allow them to project above the ground at least 12 inches. Set three bricks under each leg member, two side by side, below the surface of the ground and one resting on them, showing above the soil.

The four corner posts are drilled to receive $\frac{3}{8}$-inch diameter coach-bolts, and the holes in the mast leg members for these bolts are drilled when the mast is up.

Concrete Foundation.—When concrete foundations are decided upon, a box must be made with internal dimensions equal to the size of the finished concrete block.

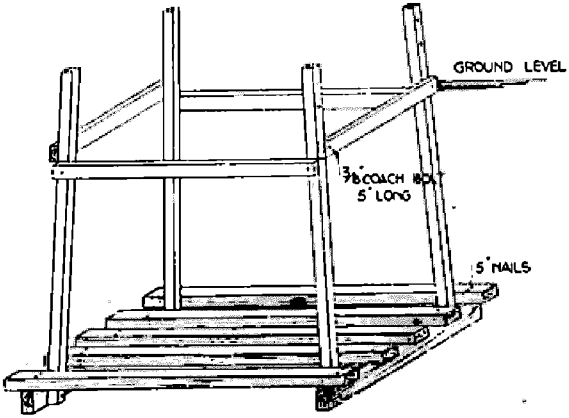


FIG. 34.—General View of Timber Foundation.

The top and bottom of the box are left open as shown in figure.

Set the box in position in the ground and insert wire netting with holding-down bolt (Fig. 30). The concrete can then be inserted through the opening in the top of the box or mould.

The amount of material required to make four concrete blocks as shown in Fig. 31, is, 400 lbs. of cement, half a load of sand, and three-quarters of a load of ballast. No doubt most amateurs will prefer to construct a timber foundation.

This method is quite efficient and much cheaper than concrete.

Erection.—The mast is placed in position, with the base of

it near the foundation, and three guy ropes attached about two-thirds up the mast.

The erection is carried out in a similar manner to that given for the stayed lattice type (page 40), see also Fig. 9.

When the mast is vertical secure the stays to temporary anchor stakes or other suitable objects (it will practically stand alone if there is no wind). The mast can then be lifted on to

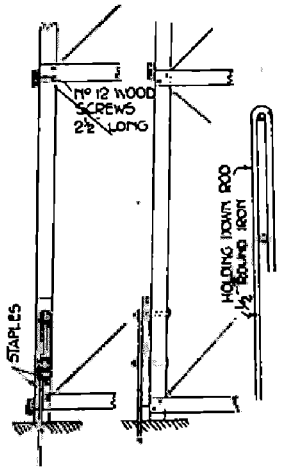


FIG. 35.—Detail of Connection for Holding-down Bolt.

its foundation and tested, for the perpendicular, with the side of a house or other vertical object. Wedges are inserted under the leg members as required and the holes drilled for the securing bolts in the leg members.

Should the size and height of the mast cause the owner nervousness, the temporary guys can be left secured for a few days until greater confidence in the stability of the mast is obtained.

QUANTITIES FOR 35-FOOT SELF-SUPPORTING MAST.

Description.	Number Required.	Length.	Size of Timber. Ordered.	Size of Timber. Received.	Feet run Ordered.	Remarks.
		ft. in.	Inches.	Inches.		
Leg member	4	11 0	2 × 2	$1\frac{7}{8} \times 1\frac{7}{8}$	50	
,, ,,	4	12 11	$1\frac{1}{2} \times 1\frac{1}{2}$	$1\frac{3}{8} \times 1\frac{3}{8}$	100	
,, ,,	4	11 1	$1\frac{1}{2} \times 1\frac{1}{2}$	$1\frac{3}{8} \times 1\frac{3}{8}$		
Horizontal struts						
(*a*)	4	3 6	2 × 1	$1\frac{7}{8} \times$		Lengths suitable for cutting up without waste.
(*b*)	4	3 $2\frac{1}{2}$	2 × 1	$1\frac{7}{8} \times$		
(*c*)	4	2 11	2 × 1	$1\frac{7}{8} \times$	60	
(*d*)	4	2 8	2 × 1	$1\frac{7}{8} \times$		
(*e*)	4	2 5	2 × 1	$1\frac{7}{8} \times$		
(*f*)	4	2 2	$1\frac{1}{2} \times 1$	$1\frac{3}{8} \times$		
(*g*)	4	1 11	$1\frac{1}{2} \times 1$	$1\frac{3}{8} \times$	25	
(*h*)	4	1 $8\frac{1}{2}$	$1\frac{1}{2} \times 1$	$1\frac{3}{8} \times$		
(*i*)	4	1 6	$1\frac{1}{2} \times$	$1\frac{3}{8} \times$		
(*j*)	4	1 4	$1\frac{1}{2} \times$	$1\frac{3}{8} \times$	18	Timber ordered to hold up to dimensions given.
(*k*)	4	1 2	$1\frac{1}{2} \times$	$1\frac{3}{8} \times$		
(*l*)	4	1 0	1 ×	1 ×		
(*m*)	4	0 $10\frac{1}{2}$	1 ×	1 ×	15	
(*n*)	4	0 9	1 ×	1 ×		
(*o*)	4	0 $7\frac{1}{2}$	1 ×	1 ×		
Internal bracing	—	—	$1\frac{1}{2} \times 1\frac{1}{2}$	$1\frac{3}{8} \times 1\frac{3}{8}$	16	
Halyard support	—	1 0	6 × 1	board.	1	
Wood-screws, iron.	1 gross	0 $2\frac{1}{2}$	No. 12.			
,, ,, iron.	1 gross	0 2	No. 10.			
Coach-bolts.	16	$\frac{5}{16} \times 4$	with nut and washer			Leg joint.
,, ,,	16	$\frac{5}{16} \times 3\frac{1}{2}$	,,	,,		,, ,,
,, ,,	16	$\frac{3}{8} \times 5$	,,	,,		Foundation Mast bases.
,, ,,	8	$\frac{5}{16} \times 6$	,,	,,		
Wire	500 ft. No. 16 S. W. G. galvanised steel wire.					
Timber foundation	4	5 0	3 × 2	$2\frac{7}{8} \times 1\frac{7}{8}$	20	
,, ,,	4	4 3	3 × 2	$2\frac{7}{8} \times 1\frac{7}{8}$	17	
,, ,,	2	5 0	$4\frac{1}{2} \times 2$	$4\frac{3}{8} \times 1\frac{7}{8}$	10	
,, ,,	5	4 9	3 × 2	$2\frac{7}{8} \times 1\frac{7}{8}$	24	

Approximate cost of material, 40/-.

CHAPTER VII

TUBULAR MAST

THE complete arrangement for a tubular mast is shown in Fig. 36, other information required is contained in Chapter II.

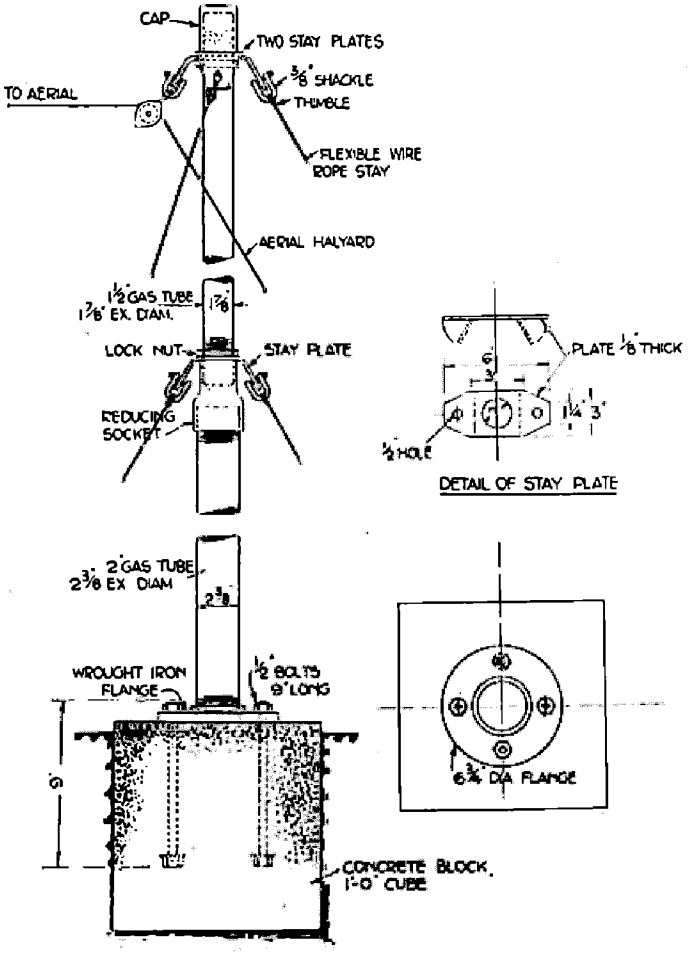


FIG. 36.—Tubular Mast Details.

The overall height of 30 feet is divided into two lengths, 16 feet and 14 feet respectively, by the stays.

The mast is made up of standard gas barrel and fittings, except the stay plate, which is shown in detail.

The lower portion of the mast consists of 2-inch gas barrel, 16 feet long, both ends being screwed 2-inch Whitworth standard gas thread.

The lower end is screwed into a standard flange for 2-inch gas and, at the upper end, a reducing socket, 2-inch to $1\frac{1}{2}$-inch gas, is fitted. Into this socket a 14-foot length of $1\frac{1}{2}$-inch gas barrel is screwed, with stay plate and lock nut attached. The size of the lock nut is $1\frac{1}{2}$-inch gas.

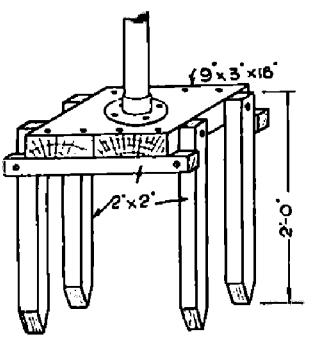


FIG. 37.—Timber Base.

At the upper end of the $1\frac{1}{2}$-inch gas barrel a lock nut is fitted, upon which two stay plates rest, the mast cap securing them.

The stays are connected at the upper end by means of $\frac{3}{8}$-inch shackles, and also the aerial pulley, which is of galvanised iron.

The stay anchors are shown in Fig. 7.

The length of stay between attachments is 33 feet 6 inches, and 22 feet respectively, neglecting the amount of wire required for splicing and securing to the anchor stakes at the base.

If insulators are inserted, the stays must be cut accordingly for their insertion. The paragraph on stays in Chapter II should be read. Stretching screws may be used, but they must not be tightened up too severely.

The mast base may consist of either timber or concrete, as shown in Figs. 36, 37.

Possibly many amateurs will require a mast of greater height; in which case, a 12-foot length of $1\frac{1}{4}$-inch gas barrel may be connected to the upper end of the 30-foot mast by means of a reducing socket, and another set of stays attached.

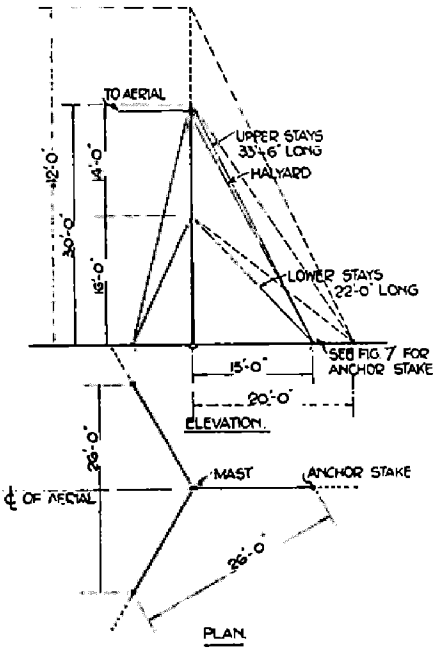


FIG. 38.—General Arrangement of Tubular Mast.

Erection.—The mast should be given a coat of paint before erection.

The method employed for erection is similar to that described for the other types of masts, only greater care is necessary, owing to its slenderness.

Place the base of the mast near the foundation, and raise the tube to an angle of 30 degrees from the ground. It may be propped up in this position while the stays are attended to.

The lower set of stays are then used as the main hoisting ropes, the upper stays being held taut to support the mast head.

CHAPTER VIII

THE AERIAL SYSTEM

THE previous portion of this book deals with one form of aerial support, namely, masts.

In this portion other suitable means are described.

The ideal conditions for an aerial system are, no doubt, ample ground space and two masts; but the first condition is not always available, and the house itself, which generally contains the receiving apparatus, is too tempting to be ignored as an aerial support in the place of one mast.

Although it is not the object of this book to describe aerial

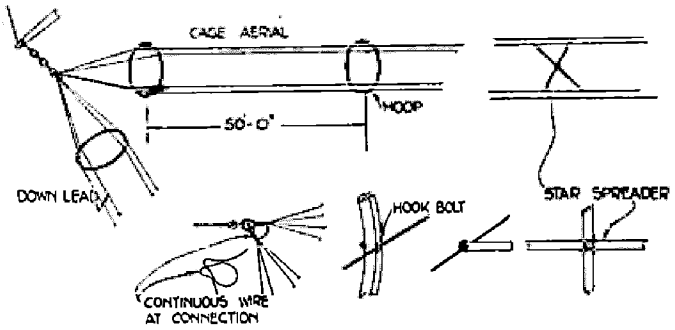


FIG. 39.—Cage Aerial and Details.

systems from the electrical point of view, but rather in the mechanical sense, yet it is not always possible to regard one without the other. Mechanical considerations, therefore, are dealt with in fuller detail here, due regard being paid, however, to electrical considerations when necessary.

The aerial consists of an electrical conductor totally insulated from earth except through the receiving apparatus.

It usually takes the form of copper or silicon bronze, single or stranded wires, suitably suspended in the air, either horizontally, vertically, or a combination of both arrangements.

A type often favoured is the invert L, but sometimes it is convenient to have it in the form of the letter T.

Either form may be composed of one, two or more wires.

For wireless reception, one wire is quite efficient, if length

can be allowed; although the twin wire type with spreaders is most generally favoured.

The sausage or cage aerial consists of three or four wires equally spaced round a hoop or star frame, as shown in Fig. 39.

This type can be used as a single sausage or twin cage with end spreaders, similar to the twin wire type, but it is hardly

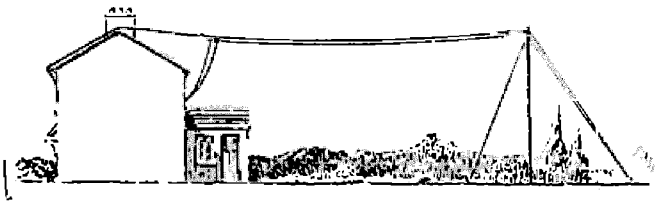


FIG. 40.—Aerial System showing Roof Halyard.

necessary for reception purposes, and is generally used at transmitting stations.

The most convenient forms of aerial systems are shown in Figs. 40, 41, 42.

The inverted L type shown in Fig. 40, has a mast support at one end, and the aerial halyard is taken over the roof at the other end.

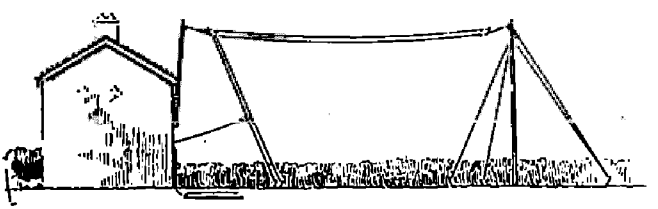


FIG. 41.—Aerial System showing Window Pole.

The erection of this aerial is probably the simplest to carry out, as it is not necessary to climb on to the roof.

One end of a ball of string is secured to a small weight, and the ball uncoiled. The weight is then thrown over the roof, from the road to the back of the house, so that passers-by are not interfered with.

The aerial halyard, which must be wire rope, can then be secured to the string, and pulled over the roof into position.

Unfortunately, some roofs have fancy ridges, but the majority are quite suitable for the purpose.

Care must be taken to keep the string clear of joints in the ridge tiles, it can be moved or freed by shaking the string sharply. On no account pull hard on it. The aerial wire or spreader is suitably attached to the roof halyard, as described elsewhere, and hauled up into position. The end of the halyard, which is on the opposite side of the house, can then be secured to a stack pipe, or connected to a piece of wood placed across the inside of a window frame similar to the arrangement shown in Fig. 43.

Frequently a chimney stack is suitably placed on the roof, and the boomerang method with the ball of string may be tried with advantage round the chimney stack.

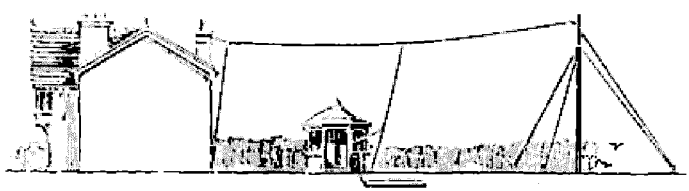


FIG. 42.—T Aerial.

One other method can be employed without going on the roof, and this is shown in Fig. 41.

Here a wood pole stands on the window sill, and is held by a special metal half-band, the pole is also lashed to a piece of timber, about 2½ inches square, which is placed inside the window, and bears against the wall a foot each way.

In order to clear the gutter, a wood chock of suitable thickness is secured to the pole with wood screws.

The aerial pulley with halyard can be attached to the pole, as shown in Fig. 1.

The pole must not be longer than 18 feet, and less than 4 inches diameter at the butt, and 3 inches diameter at the top.

In any case, the length of pole projecting above the lashing must not be more than 12 feet, and at least 3 feet must exist between the metal band at base and the lashing. This pole will then support a single or twin wire aerial.

Height of Houses.—The question of height is rather deceptive, and it is often necessary to know the height to a certain window, gutter or ridge.

This may be easily estimated by the following method.

The average two-storey house is approximately 20 feet to the gutter, with a rise of about 12 feet to the ridge of the roof.

If one allows 9 feet for each storey in a house, plus 2 feet, together with the rise in the roof, the height of any house can be fairly estimated.

Again, the height and size of a chimney stack may be required, to avoid the use of mathematics count the layers of bricks for height. These are 3 inches each together with one thickness of mortar, or, better still, check this by measuring the dimension for one brick with mortar at the side of the house.

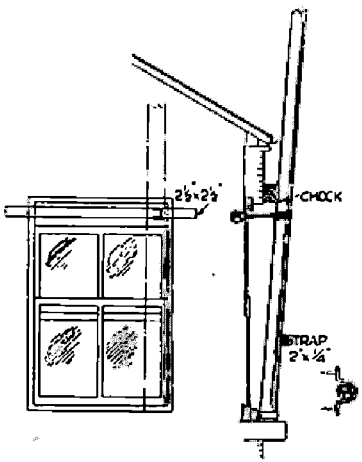


FIG. 43.—Method of Securing Window Pole.

For width: A brick lengthwise is 9 inches, and endwise 4½ inches. They are always laid this way, hence a good idea of the width of a chimney can be formed by counting the number of bricks.

Sag in Aerial Wires.—A few precautions taken with regard to the aerial wire will considerably increase its length of life, and save the trouble and inconvenience of re-erecting the aerial when it carries away.

The aerial now allowed by the Postmaster-General has a maximum length of 100 feet irrespective of the number of wires measured from the receiving instrument to the far

insulator. This allows about 80 feet in the horizontal arm, plus about 15 feet of horizontal halyard wire at the leading-in end.

Say 100 feet span altogether between attachments.

Under normal conditions the aerial may be pulled up to 1 foot sag, but in a gale or during cold and frosty weather 3 feet sag should be allowed.

If the aerial is erected at a temperature of 55° F., with 10 degrees of frost, the temperature variation would be 33° F. This, in itself, can be neglected, as the contraction in length due to this change of temperature is small.

If, however, the wire becomes covered with ice or snow, it

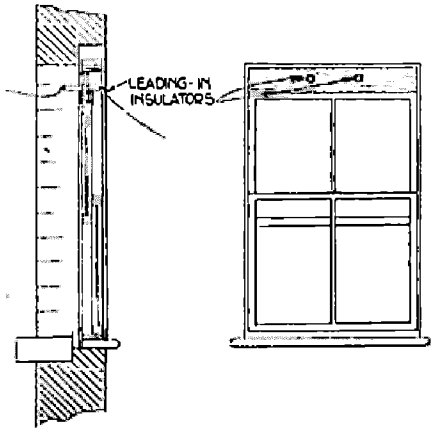


FIG. 44.—Lead-in for Ordinary Window.

is stressed, due to the extra weight carried, and may collapse under the combined stresses due to contraction and weight of ice.

Remember contraction in length produces a decrease in the sag with an increase in tension or stress in the wire.

Generally, in the south of the British Isles the formation of ice on the aerial will be a rare occurrence, but in the northern area it must be expected during the winter season. It is therefore advisable to slack away the aerial when not in use, and especially in bad weather.

It is useful to note that insulators covered with ice cease as such and become conductors. Hence you need not expect to receive signals under these conditions.

"*Leading-in*" *Insulator.*—Frequently a piece of insulated flexible wire is used for "leading-in," that is, connecting the aerial downlead to the receiving apparatus.

In order to connect up the receiving set with the aerial, the leading-in wire can be brought through an open window, or through a tube of glass, ebonite or porcelain, inserted in the window frame or wall of the house.

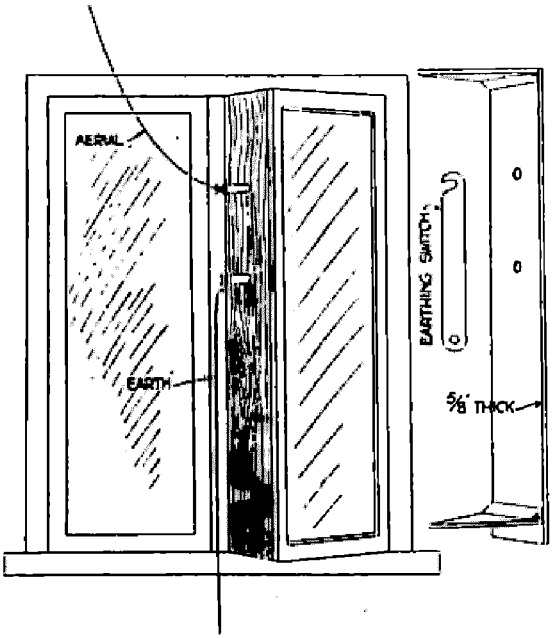


FIG. 45.—Lead-in, Casement Window.

Figs. 44, 45, 46 show arrangements for fixing leading-in insulators to various types of windows.

This fitting is easily removed, and when in place overcomes the disadvantage of an open window in bad weather or a hole through the wall.

Also, with this arrangement a second insulator can be fitted for the earth wire if desired, and an aerial earthing switch, consisting of a strip of brass or wire, attached to the outer side

of the fitting, or the aerial lead connected directly to the earth wire.

The " leading-in " insulator consists of a tube of porcelain, ebonite or glass, with a central brass rod, screwed and supplied with nuts at both ends (Fig. 47). The fitting for the insulator being of wood about $\frac{3}{4}$ inch thick, cut as shown in the illustrations to fit the window desired.

Earth.—The position of the receiving apparatus depends upon three factors:—

The leading-in of the aerial wire, the proximity of the earth system, and a suitable location for the convenience of the

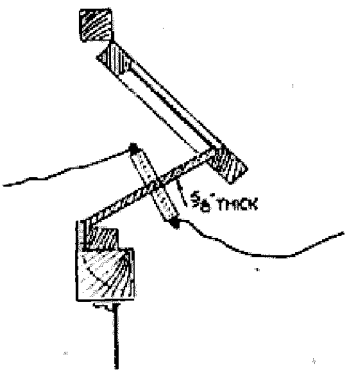


FIG. 46.—Lead-in Faulight.

people listening. Generally a compromise between these three important considerations must be made.

The lead from instruments to earth should be as short as possible and arranged to give a rapid distribution to earth.

The amateur often reads that a good connection can be made to a water-pipe; this, however, has some drawbacks, although it has been successfully employed in the past, and will, no doubt, be frequently used in the future.

The disadvantages are:—

(*a*) It is difficult to solder on to a lead or iron pipe, especially when it contains cold water.

(*b*) Long-wandering leads are often necessary to reach the pipe, and these become a general nuisance through rooms and doors.

(*c*) The water-pipe unfortunately does not run to earth direct (except through the brickwork), but up into the attic where the cistern is located, from here it wanders away down to the ground, where the actual earthing may be considered to

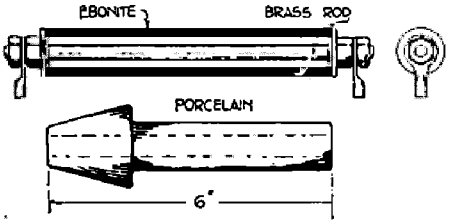


FIG. 47.—Leading-in Insulator.

commence; this, however, does not give an earth system under the actual aerial where it is advisable to place it.

(*d*) The earthing switch, if installed in the circuit, must be inside the house.

Note.—At some future date regulations or a fire insurance

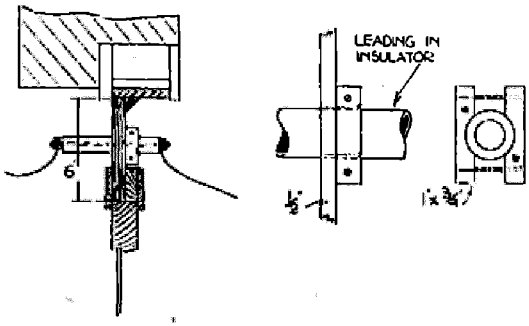


FIG. 48.—Method of Securing Leading-in Insulator.

policy may demand an efficient aerial earthing switch outside the house.

Against these objectional points, one must say that a metal clip or copper wire seizing may be employed with success instead of soldering. Also, the apparatus may be installed near to the water-pipe system and portable leads for 'phones or loud speaker employed.

The water-pipe system is not always the only means at the amateur's disposal.

An alternative method is an outside earth system, which can be arranged in quite a simple and inexpensive manner, by burying horizontally an earth plate at least 2 feet in the ground.

The plate should be as near as is possible to the leading-in wire and preferably under the aerial.

The earth plate may consist of galvanised wire netting, galvanised iron sheet, a zinc plate, or any conductor.

The wire netting should cover about 20 square feet of area, the sheet iron or zinc being about 6 feet × 3 feet.

It is an advantage to join a few (four to six) copper wires

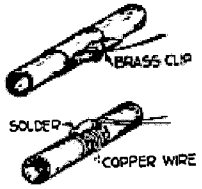


FIG. 49.—Earth Connection to Water-pipe.

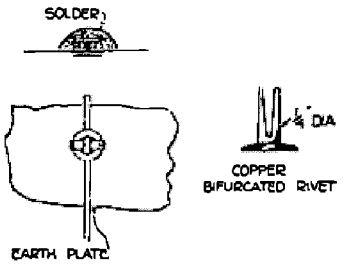


FIG. 50.—Earth Plate Connection.

(No. 16 S.W.G.) to the earth plate and spread them out radially.

If the leading-in fitting with two insulators, shown in Fig. 44 is used, the earth wire may be brought down the side of the house to the earth plate.

A good plan is to make this earth lead of three strands of No. 16 S.W.G. copper wire, stranded together, and spread them out so that they meet the plate at three different points.

The wires should then be riveted to the plate with bifurcated copper rivets and washers (Fig. 50), and then the whole well soldered.

The radial wires from the earth plate must be treated in a similar manner at their connections.

One essential point must not be overlooked. The earth system in very dry weather requires moisture, so that the ground should be watered in the vicinity of the earth plate.

Insulators.—Insulators are designed to meet three conditions :—

(*a*) To give mechanical strength.
(*b*) To resist electrical pressure.
(*c*) To direct rain-water or moisture away from the wires attached to them.

In receiving aerials insulators are not subjected to great mechanical and electrical stresses ; however, the correct type should be chosen for the duties they have to perform.

In the aerial wire their principal function is to resist electrical pressure. Their insulation properties are generally ample for

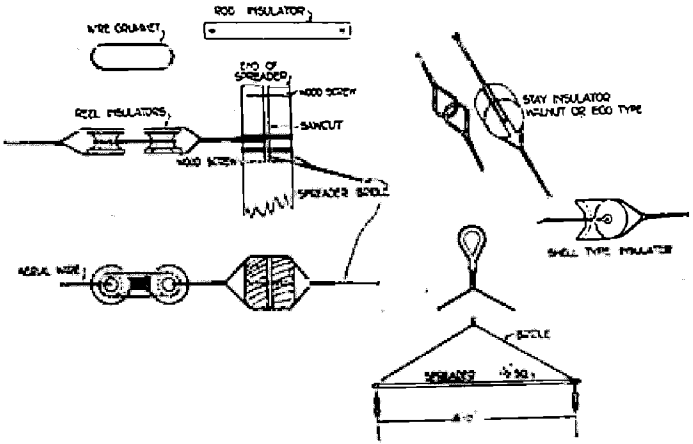


FIG. 51.—Insulators and Spreader.

this in dry weather, but with rain or moisture, they may have a certain amount of surface leakage, and it is therefore important to insert those which possess a good drip point.

To overcome surface leakage in damp weather two or more insulators are connected in series.

Fig. 51 shows the reel type attached at the end of a spreader, also the shell type.

Stay insulators should be similar to the one shown in Fig. 51, called the egg or walnut type.

The eyes in each portion of the stay wire embrace each other, and should the insulator break the stay does not part and allow the mast to collapse.

Never use a strain or rod insulator in mast stays.

Roof Attachments.—To return again to the house as an aerial support is, perhaps, to look for trouble, but as so many amateurs have no other alternative, a few suggestions are put forward and illustrated.

The fixing of a suitable pole on the roof of a building is one of the difficult problems which confront the amateur.

Unfortunately there are no simple devices which can be followed, so that the only course left open is to face the matter properly and use orthodox methods in order to get on to the roof.

A workman employs two ladders, one by which he climbs

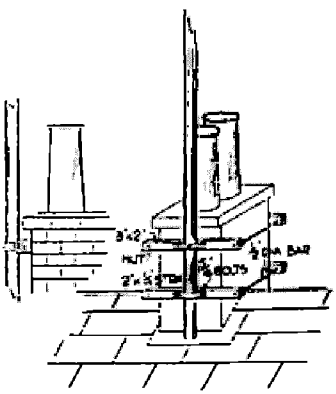


FIG. 52.—Method of Securing Pole to Chimney-stack.

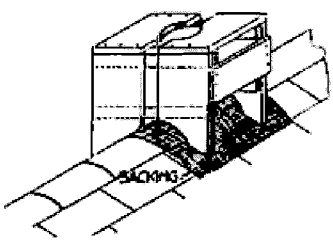


FIG. 53.—Ridge Housing Box Type.

to the gutter, and with the other placed on the slope of the roof he reaches the desired position.

It is advisable to have wood chocks, at the upper end of the roof ladder, in order to obtain a grip on the roof ridge.

Generally, it is difficult to obtain the necessary ladders, so that it is by far the better and safer plan to get a builder to carry out the work, and obtain the owner's consent.

If it is possible to reach the roof, the best plan is to secure the pole to a chimney-stack (see Fig. 52).

It is advisable to make the fittings strong and secure, so that they will stand without attention for some considerable time.

It may be useful to know that the ordinary chimney-stack cannot be encircled by the arm; if, however, it is low, work

can be carried out between the chimney pots in order to pass the connecting pieces round.

A simple plan is to use a piece of string or cord weighted at the end, and swing this round the stack (keep clear of its return). A wire lashing or connection for the pole may then be passed round.

When it is necessary to mount the pole to a chimney-stack, all stays and halyards, together with seizing, must be of wire, as there may be a considerable amount of heat emitted from the chimney, which will in time destroy any ropes made of hemp or other similar substance.

Figs. 53, 55, show arrangements for a mast housing on the

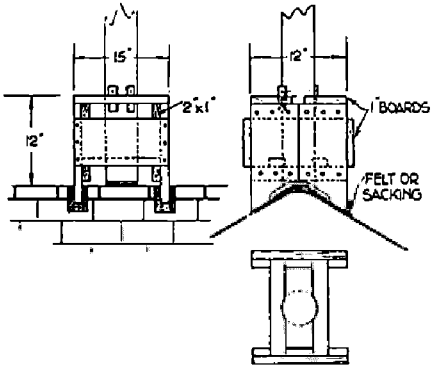


FIG. 54.—Details of Fig. 53.

ridge of a roof, and are put forward as a suggestion to overcome a difficult proposition. The box type can be employed for a short pole up to 12 feet, while for longer poles the skeleton type should be used. The design shown is suitable for poles up to 18 feet in length.

With either type of housing the pole must be stayed with four wires, as equally spaced round it as possible. Chimney-stacks can be used as anchors with advantage. No stays should ever be fixed to the chimney pots themselves, and, where not available, the stay can be brought over the gutter, down to the ground, or fastened to the wall near a window (Fig. 57).

The general scheme of things is illustrated in Fig. 58, and roof ties of wire rope are employed.

Gutter chocks of wood are employed, as shown in Fig. 59, care being taken to leave sufficient room for rain water to pass.

The complete system must be kept firm, therefore turnbuckles are inserted in the stays.

It is of the utmost importance not to tighten them up too severely, or a heavy vertical load will be placed on the roof.

Directly the slackness in the stay disappears, tightening up should cease.

The pole should be pulled vertical with the stays by hand, and the slight initial tension only produced by means of the turnbuckles.

The wall nails and staples must always be driven into wood

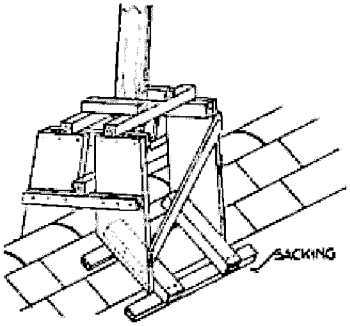


FIG. 55.—Ridge Housing Skeleton Type.

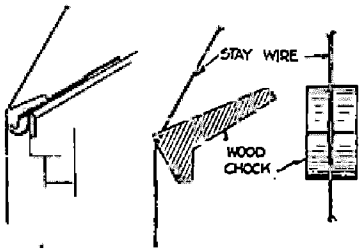


FIG. 59.—Gutter Chock.

plugs inserted in the wall between bricks, after the mortar has been removed for a depth of 3 inches.

A useful device for raising the pole into the vertical position is shown in Fig. 60.

Two stout boards are secured temporarily to the housing (Fig. 56), and by means of a bolt hinge at their upper end the pole is swung up vertically, and thus securely held during the process. When the pole is vertical it is lashed in position, while the bolt is removed, and the pole inserted in its bed.

The stays and halyard, which are fitted to the pole before erection, can then be attached to their respective positions and secured, after which the two temporary boards and lashing are removed.

Erection of the Aerial.—The first consideration when erecting an aerial is to decide on the type to suit your local surroundings and requirements.

It is advisable to get slightly above the roofs of houses, away from trees or other surrounding objects, to prevent screening effects; but in most cases you are given no choice of site, so that you need only be concerned with regard to the type and possible attachments.

Various types of masts have been given, and also attachments to the house, so, assuming these decided upon and erected, the next thing is to prepare your aerial wire, insulators, spreaders, etc.

First, you must ascertain the length between attachments, then allow for the length of the halyard horizontally, spreaders, insulators, etc.

If possible, lay the complete aerial out on the ground between

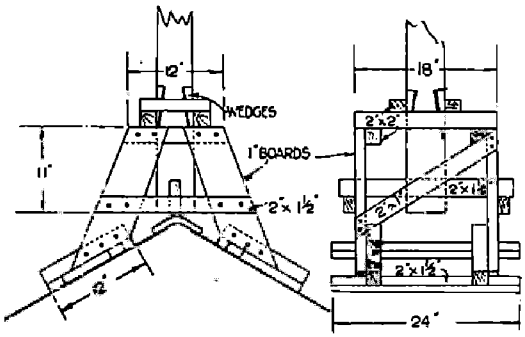


FIG. 56.—Details of Fig. 55.

attachments, and secure one end of the aerial wire to the insulators at the far end of the aerial, and unroll the coil along the ground.

At the leading-in end the aerial wires should be temporarily secured with a piece of string, and the complete aerial hauled up to test its correct length, and also the possible length of down leads. Adjust the aerial wire at the leading-in end as necessary, and make it secure to the spreader insulators.

The aerial may again be hauled into position, and the end of the downlead cut to length and soldered to the connection thimble of the leading-in insulator. Always make the length of aerial from leading-in insulator to far end one continuous length of wire. The general arrangement of the aerial wire and its connections is shown in Figs. 56, 61.

A saw-cut at either end of the spreader is a simple device, and two screws are inserted, one to prevent splitting at the saw-cut, while the other locks the seizing.

The screws should be brass, so that they can easily be removed when necessary, iron screws will rust in, and be difficult to extract.

The aerial insulators are connected by a wire grummet, No. 16 S.W.G. copper wire being quite serviceable, and the grummet seized together in the middle after the insulators are inserted, to hold them securely in position.

The downlead end of the aerial should be kept well away from the house, and it is often a good plan to pull them away with tail wires attached to stakes in the ground. The leading-in wire is then brought to its insulator at an angle, and not parallel with the wall, which is bad.

Aerial Details.—Several details of the aerial have already been described under other headings, so that brief reference to them need only be made here.

Spreader.—This usually consists of an ash spar for strength and lightness and is about 6 feet long, an ordinary piece of wood, 1½ inches square at the centre and tapered to an inch each end, may be used ; or a stout bamboo pole.

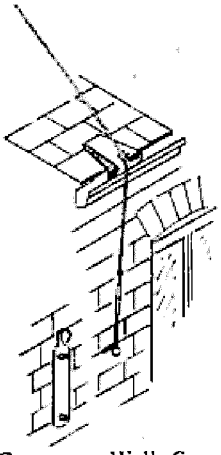


FIG. 57.—Wall Connection for Stay or Halyard.

Fig. 51 shows the general arrangement of the spreader with the bridle ; while Fig. 61 gives an aerial with spreaders attached and method of arranging for the downlead in a **T** aerial.

Should a cage aerial be employed the wires may be separated with wood hoops spaced about 50 feet apart. A child's hoop serves the purpose well, or two pieces of bamboo cane may be seized together in the form of a cross as shown in Fig. 39.

The downlead with tail wire, and method of taking the aerial wire to leading-in insulator are detailed in Fig. 61. The tail wire may be a spare piece of aerial or stout string ; do not make it too tight, or you will decrease the height of your aerial.

The actual leading-in wire may be fairly slack, so as not to strain the leading-in insulator and fitting.

When uncoiling the aerial wire it is a good plan to fasten one end to a firm object, and then unroll the wire by rolling the coil along the ground like a hoop ; this prevents kinks forming in the wire. Should the wire break at any time, and need joining, the two ends should be seized together and well soldered.

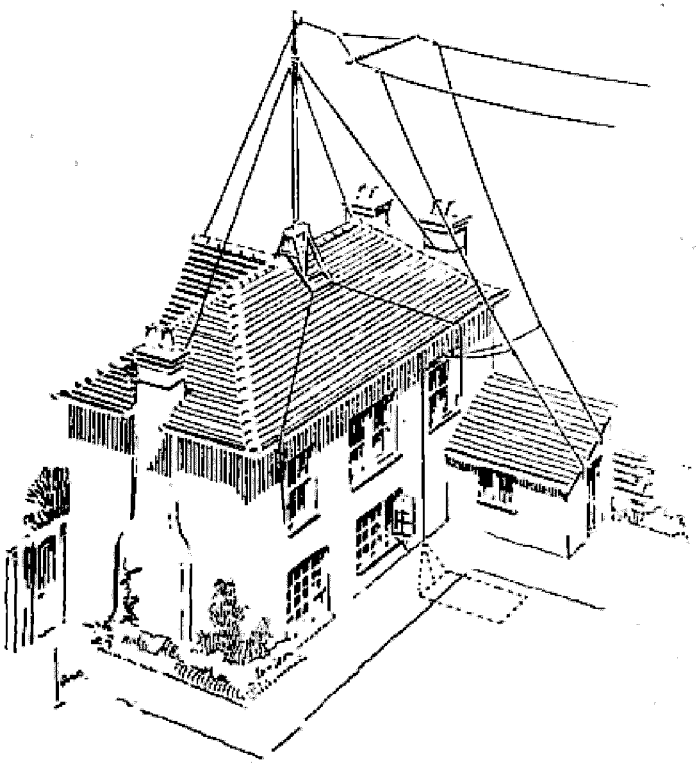


FIG. 58.—General View Roof Housing and Aerial.

The aerial halyard block, or pulley, should be of galvanised iron. The wheel is called a sheave, and the complete fitting a block.

With each type of mast the method of attaching the halyard block is shown.

The halyards and various insulators are dealt with under their respective headings.

All shackles should be of galvanised iron. They run in sizes termed $\frac{1}{4}$-inch, $\frac{3}{8}$-inch, $\frac{1}{2}$-inch, etc., which is the diameter of the metal of which it is formed ; $\frac{3}{8}$-inch shackles are a handy size to use.

Thimbles are of galvanised iron and run in sizes, $\frac{3}{4}$-inch, 1-inch, $1\frac{1}{4}$-inch, etc. These dimensions are the circumference of the rope they suit.

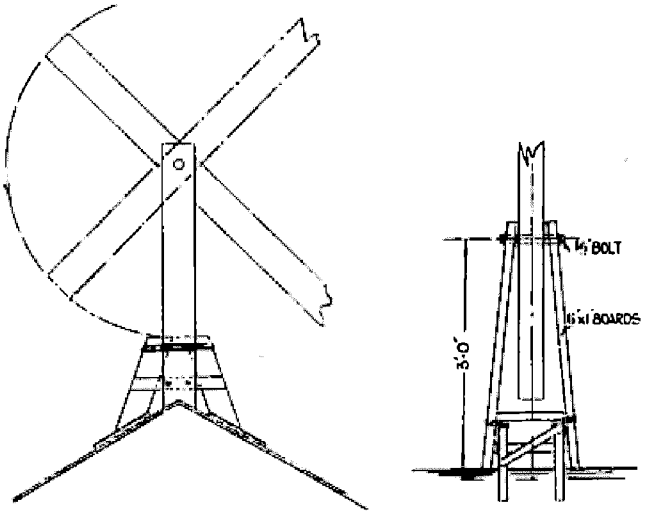


FIG. 60.—Erection of Ridge Pole.

Convenient sizes for use are $\frac{3}{4}$-inch and 1-inch, but it is necessary to be able to pass a $\frac{3}{8}$-inch shackle through them.

It is advisable to use thimbles at every bend in a wire.

Soldering.—Soldering consists of two classes, hard and soft. Soft soldering is the method generally employed for making electrical connections.

This again is sub-divided into two classes, soft and hard, which depends upon the substances to be joined.

Solder is composed of tin and lead in various proportions, the more tin the higher the melting point, and stronger joint, and *vice versâ*.

It naturally follows that for earth wire connections to lead

pipes the softest solder must be used. The proportions commonly used by plumbers are two of lead and one of tin, or equal parts of each.

For copper wire connections to brass terminals, two of tin and one of lead.

The ironmonger, as a rule, only keeps two classes in the proportions two tin and one lead, and one to one, known as hard and soft respectively.

Use hard for brass, iron and copper work, and soft for lead pipes.

Several factors constitute a good soldering job: cleanness of work, work sufficiently warm, soldering iron or bolt properly tinned, and correct flux used.

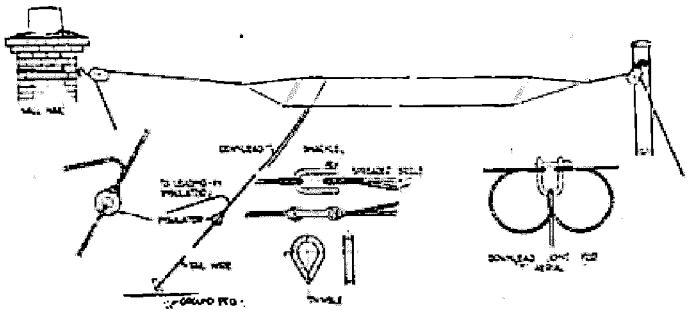


FIG. 61.—General Details of Aerial.

The fluxes for soldering are as follows:—

Iron or steel . . .	Borax or sal ammoniac.
Tinned iron . . .	Resin, zinc chloride.
Copper, brass . .	" "
Zinc	Zinc chloride.
Lead	Tallow or resin.
Lead and tin pipes. .	Resin and sweet oil.

Compounds can be bought for general service work, such as fluxite.

For electrical connections the use of acid or zinc chloride is avoided, resin being the principal flux.

The work to be soldered must be thoroughly scraped or cleaned and free from grease. Do not wipe your fingers over the surface. The point of the soldering iron must also be

cleaned (by filing it bright) and the iron heated (never let it get red hot). When the iron is of sufficient temperature to melt the solder, clean the point again with a file, and first dip it into the flux, and then on to the solder, when, if properly done, a bead of solder will remain on it; with a clean piece of rag wipe this bead over the surface. The point is then tinned. Always keep the iron well hot and do not walk about with it. Between each operation it should be replaced in the flame or other heating apparatus, and when possible keep the tinned point away from the smoke of the flame or fire.

The two surfaces to be joined together are scraped or rubbed bright with emery paper, touched with the soldering flux, and then tinned. A bead of solder on the hot iron being sufficient for this purpose.

The iron is again heated and a little solder melted over the joint, the heat of the iron causing it to run.

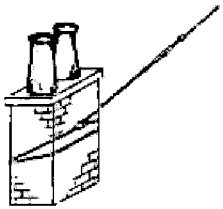


FIG. 62.—Stay Attachment to Chimney-stack.

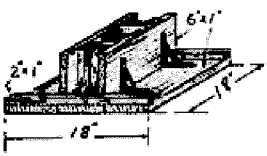


FIG. 63.—Pole Housing for Flat Roof.

It is often convenient to hold the work down with the hot iron, in which case you must wait a little while for the iron to cool and the solder to set.

When soldering on to a lead water-pipe, first free it from water, and scrape a portion clean. A little flux can be applied over this surface with a clean rag and a coating of solder given.

Clean the earth wire, tin its end, and make your connection by means of a hot iron and solder. Care being taken not to melt the pipe.

A method often employed with lead pipes is to bind copper wire round the pipe and solder your connection to this wire. Damage to the lead pipe with the hot iron is then prevented.

Never make your earth connection to the water-tap. This is fitted with a leather washer or a red-lead joint, and has not a good metal contact.

Frame Aerials.

One type of aerial used when ground space or roof attachments are not available, is called a frame aerial.

It is portable and convenient to use in residential flats, provided that for the weaker signals a multi-valve set is employed.

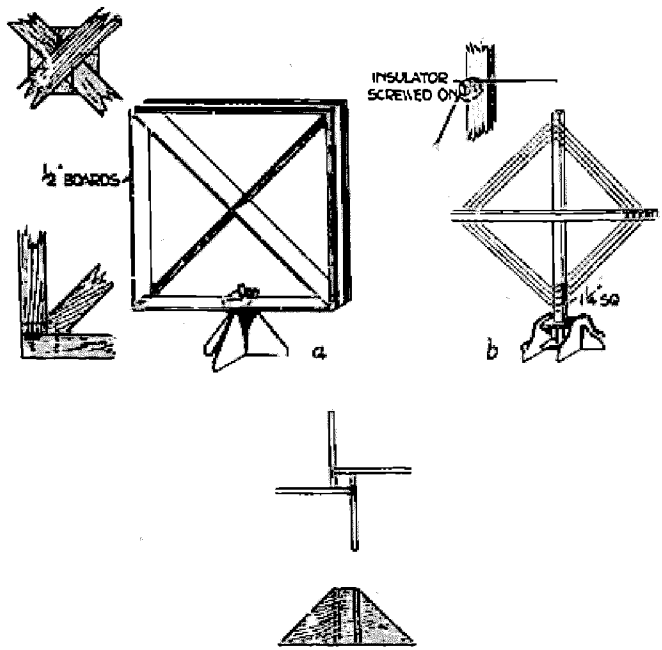


Fig. 64.—Frame Aerials.

Two useful types are shown in Fig. 64. Type (*a*) consists of a square frame composed of boards ½ inch by about 6 inches, the frame being from 4 feet to 6 feet square. Type (*b*) is a simple star.

Frame aerials give the best signals when set in the plane of the station being received, and therefore they are made to revolve about the base, which must be of ample dimensions to obtain rigidity.

This feature is made use of in direction-finding stations.

Generally, the position of the transmitting or broadcasting station is known, in which case the frame aerial is set in the plane of this direction.

The aerial wire used may be insulated wire, or bare copper wire wound on insulating tape, paraffin wax or shellac varnish. Another method is to use small reel insulators, attached with screws as shown in type (*b*).

The aerial wire is sometimes wound with two or more independent coils; these are connected by a suitable switch, and thus a change of wavelength can be effected.

The Frame aerial chart will be found very useful in cases where it is desired to design frame aerials for reception of definite wavelengths. The chart is due to A. S. Blatterman, and was published in the *Journal of the Franklin Institute*. Let us suppose that we wish to know the best combination of size of frame, number of turns, and spacing for reception on 2,500 metres. Reference to the lower portion of the chart will show the following :—

Size of Loop.	No. of Turns.	Spacing.
4 feet.	50	$\frac{1}{4}$ inch.
6 feet.	40	$\frac{7}{16}$ inch.
10 feet.	23	$\frac{3}{4}$ inch.

Next, referring to the top portion of the chart, we find that the all-important " reception factor " for each of the above sizes of loop is as follows :—

Size of Loop.	Reception Factor.
4 feet.	6,400
6 feet.	9,300
10 feet.	8,600

which shows that to receive a 2,500-metre wave, a 6-feet loop with forty turns $\frac{7}{16}$ths of an inch apart is the most efficient of the examples given.

This requires a large wide frame, but it should be noted that these dimensions are not *essential*. They are, however, the *best* for 2,500 metres.

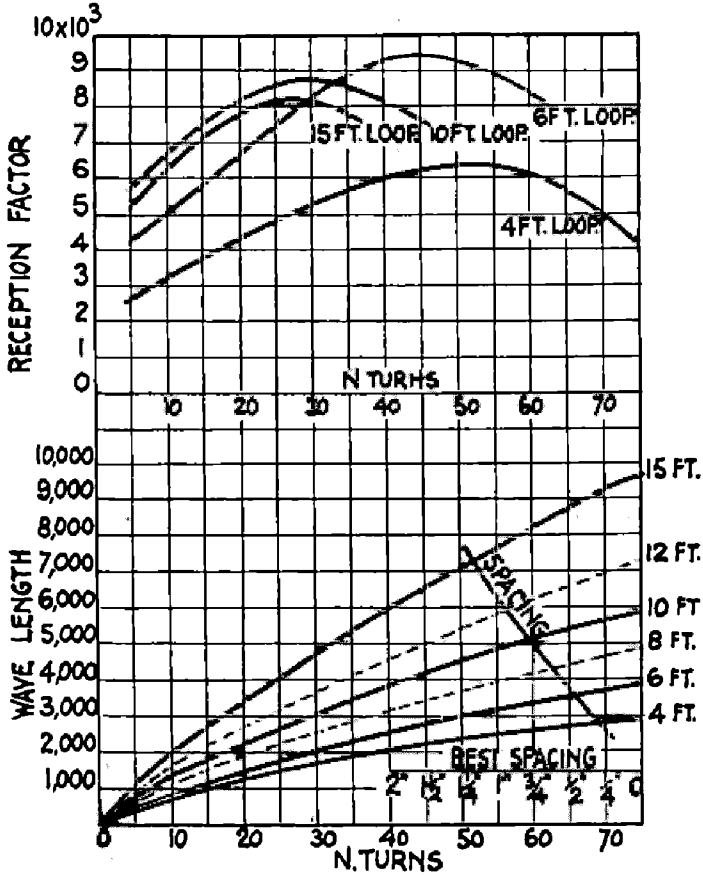


FIG. 65.—Frame Aerial Chart.

For the purpose of tuning a condenser may be used in conjunction with a frame, but the maximum capacity of this should not exceed ·001 microfarad.

For wavelengths below those given on the accompanying

chart, it is best to find the exact number of turns from experiment rather than calculation, as the exact spacing of the turns will be an important factor, and the number of turns so few that it is very little trouble to the experimenter to wind on a suitable number to suit his own purpose.

When the receiving station is situated in the vicinity of the broadcasting station, say a mile away, audible signals can often be received with an aerial wire stretched across the room or along a passage, provided it is suitably insulated at attachments.

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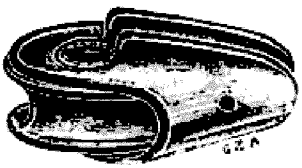

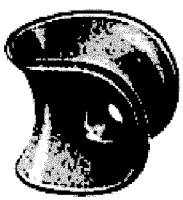

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